Ecosystem Revitalization @ Route 66, Albuquerque, New Mexico
Section 1135 Project

Detailed Project Report and Environmental Assessment

July 2008

US Army Corps of Engineers®
Albuquerque District

U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

FINDING OF NO SIGNIFICANT IMPACT for the

ECOSYSTEM REVITALIZATION @ ROUTE 66 PROJECT ALBUQUERQUE, NEW MEXICO

Under the authority of Section 1135 of the Water Resources Development Act of 1986, the U.S. Army Corps of Engineers (Corps) proposes to implement the Ecosystem Revitalization @ Route 66 Project (Route 66 Project). The Route 66 Project would include removal of jetty jacks and non-native vegetation across 121 acres of bosque north and south of Central on the west side of the river and north of Central on the east side of the river. Non-native vegetation to be removed would include salt cedar (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), Tree of Heaven (*Ailanthus altissima*) and Siberian elm (*Ulmus pumila*). The proposed action also includes recreating 3 high-flow channels, and enhancing one outfall wetland at the Gonzales Drain. Further restoration features include planting of native vegetation throughout the project area (121 acres) and creation of a number of willow swales. Improvements of existing facilities for educational, interpretive and low-impact recreational uses have also been incorporated into the Route 66 Project.

Studies for the Route 66 Project began in 2002, and a scoping letter was sent to all relevant Federal, State and local agencies, as well as a number of non-governmental organizations and miscellaneous other stakeholders with ongoing projects in the bosque. Public review of the Draft Detailed Project Report/Environmental Assessment was held from March 19 through April 18, 2008. A public meeting was held on April 2, 2008.

Alternatives considered include a number of solutions throughout this geographic area. Each solution consisted of a variety of measures. One alternative considered implementation of all solutions in all areas, which was deemed too costly to meet the project goals and objectives. Another alternative considered was no action. The goals and outputs were identified and small variations of management measures were used to evaluate alternatives. This allowed the team to determine the most cost-effective version of the alternative. Alternatives were analyzed and compared to environmental outputs. An ideal reference reach based on a mixed riparian wetland community was used as the preference within the current river regime.

All Best Management Practices described throughout the document would be adhered to during project implementation including: 1) management of sediments, 2) inspection of equipment, 3) compliance with all water quality permits, 4) adherence to the schedule and best management practices discussed in order to avoid impacts to endangered or protected species, or avian nesting species, and 5) oversight by a qualified biologist to monitor adherence to these conditions during construction. These and all other conditions listed in the Environmental Assessment, Fish and Wildlife Coordination Act Report, and Biological Opinion would be adhered to during construction.

If the planned action did not occur, long-term restoration of the ecosystem functions of this area could not be achieved. Local agencies would continue to perform maintenance of non-native vegetation as they are able, but the features connecting the bosque and river would not be constructed. The proposed action offers a balance of thinning of fuels and removal of non-native vegetation, jetty jack and debris removal, creation of moist soil and wet habitat, creation of recreational features and revegetation that would improve the function of the ecosystem in the Study Area, with the ultimate goal being a more sustainable, restored bosque.

Section 404 of the CWA requires analysis of the EPA's 404 (b)(1) Guidelines if the Corps proposes to discharge fill material into a water or wetlands of the United States. A 404 (b)(1) Evaluation was performed for this project (Appendix E). The 404 (b)(1) analysis has been completed for Nationwide 33 and there will not be more than minimal impacts to the environment due to the proposed dredging. All conditions for the Nationwide 33 would be adhered to during construction. A water quality certification permit under Section 401 of the CWA would be obtained prior to construction. The Corps will coordinate with the New Mexico Environment Department regarding activities and schedules to allow the opportunity for monitoring water quality conditions during project implementation.

The planned action would result in only minor and temporary adverse impacts on air quality, land use, soils, aesthetics, vegetation, wildlife, recreational resources, water quality, and noise levels during implementation. The long-term benefits of the proposed project would outweigh these short-term adverse impacts. The following elements have been analyzed and would not be significantly affected by the planned action: socioeconomic environment, hydrology and hydraulics, water quality, noise levels, floodplains, riparian areas, wetlands, waters of the United States, biological resources, endangered and threatened species, prime and unique farmland, and cultural resources.

The proposed action has been fully coordinated with Federal, Tribal, and local governments with jurisdiction over the ecological, cultural, and hydrologic resources of the study area. Based upon these factors and others discussed in detail in the Detailed Project Report/ Environmental Assessment, the proposed action would not have a significant effect on the human environment. Therefore, an Environmental Impact Statement will not be prepared for the conduct of the subject project.

23 Jul 08
Date

For Kimberly Colloton
Lieutenant Colonel, U.S. Army
District Engineer

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List of Acronyms

AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
AOP	Albuquerque Overbank Project
AOSD	City of Albuquerque Parks and Recreation Department, Open Space Division
AWRMS	Albuquerque Water Resources Management Strategy
BAP	Bosque Action Plan
BCOS	Bernalillo County Open Space
BCSS	Bernalillo County Soil Survey
BEMP	Bosque Environmental Monitoring Program
BIA	United States Bureau of Indian Affairs
BIG	Bosque Improvement Group
BIT	Bosque Interagency Team
BLM	United States Bureau of Land Management
BMP	Best Management Practice
BLU	Biophysical Land Unit
CFS	Cubic Feet per Second
COA	City of Albuquerque
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ESAC	Middle Rio Grande Endangered Species Act Collaborative
ET	Evapotranspiration
GRF	Gradient Restoration Facility
HU	Habitat Unit
I-40	United States Interstate 40
LERRD	Lands, Easements, Rights-of-Way, Relocations and Disposal/Borrow Areas
LUST	leaking underground storage tank
MOU	Memorandum of Understanding
MRGBBMP	Middle Rio Grande Bosque Biological Management Plan
MRGESCP	Middle Rio Grande Endangered Species Act Collaborative Program
MRGBI	Middle Rio Grande Bosque Initiative
MRGCD	Middle Rio Grande Conservancy District
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
NMED	New Mexico Environment Department
NMISC	New Mexico Interstate Stream Commission
NMSP	New Mexico State Parks
NPDES	National Pollution Discharge Elimination System
OMRR&R	Operations, Maintenance, Repair, Replacement and Rehabilitation
RGSM	Rio Grande Silvery Minnow
RGVSP	Rio Grande Valley State Park
OSE	New Mexico Office of the State Engineer
SSCAFCA	Southern Sandoval County Arroyo Flood Control Authority
SWCD	Soil and Water Conservation District
SWPPP	Storm Water Pollution Prevention Plan
UNM	University of New Mexico
URGWOPS	Upper Rio Grande Water Operations and Procedures Study
Corps	United States Army Corps of Engineers
USBOR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WIFL	Southwest Willow Flycatcher

Section 1 Introduction and Background

1.1 Study Authorization, Scope, Purpose and Need

This Feasibility Study is being conducted under the authority of Section 1135 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662). The objective of this authority is to improve the quality of the environment through modification of the structure or operation of existing water resources projects constructed by the CORPS, providing modifications that are feasible and consistent with the original project purpose. Improvements in ecosystem structure and function in areas adversely affected by such projects are also included in this Study.

The placement of levees and installation of Kellner jetty jacks for bank stabilization on the Rio Grande and some of its tributaries (Public Law 80-858) have contributed to the degradation of riparian/wetland ecosystem functions and values. Additionally, the completion of the Jemez Dam on the Jemez River in 1953 which was authorized for sediment control (Public Law 80-858), and Cochiti Dam on the Rio Grande, in 1975 authorized for flood and sediment control (Public law 86-645) reduced the frequency and intensity of overbank flooding contributing further to the degradation of riparian ecosystem functions and values of the Middle Rio Grande bosque. All of these projects are part of the comprehensive flood control plan for the Rio Grande watershed authorized in the Flood Control Act of 1948.

The purpose of the Study is to determine the advisability of undertaking ecosystem restoration measures to improve the Rio Grande bosque ecosystem function in central Albuquerque. Potential alternatives include removing jetty jacks and non-native vegetation, such as salt cedar, Russian olive and Siberian elm, enhancing existing high-flow channels, outfall wetlands, and other alterations to the floodplain. Improvements of existing facilities for educational, interpretive and low-impact recreational uses have also been considered in the Route 66 Project. The Study began in 2002, and a scoping letter was sent to all relevant Federal, State and local agencies, as well as a number of non-governmental organizations and miscellaneous other stakeholders with ongoing projects in the bosque. A copy of the scoping letter is included in the Appendix A.

The objectives of this project are:

- To enhance native cottonwood-willow communities within the bosque, through the following activities:
  - reducing the number and size of non-native dominant stands within the bosque,
  - replanting highly disturbed areas (burn sites, dumps, and non-native vegetation removal areas) with native plant species, and
  - selectively removing non-native understory plants and replanting with native plants to create greater stand and edge diversity (age, size and composition).
- To enhance and increase the number of water-related habitat features in the bosque.
- To implement limited measures to rehabilitate some hydraulic connection between the bosque and the river consistent with operational constraints.
- To protect, extend and enhance areas of potential habitat for listed species within the existing bosque.
- To prevent catastrophic fires in the bosque through the reduction of fuel loads identified as hazardous.
- To develop and implement with the sponsor a long-term Operations, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) plan and long-term monitoring strategy.
- To coordinate and integrate related project planning and monitoring with other ongoing restoration and research efforts in the bosque.
- To increase access and opportunities for education and low-impact recreation that is compatible with ecosystem integrity.

This Detailed Project Report/Environmental Assessment (DPR/EA) of the Study addresses only those activities proposed for implementation by Corps under the Section 1135 Program.

1.2 Study Area Location and Sponsor

The Study Area is a riparian area located within the middle reach of the Rio Grande in New Mexico (Middle Rio Grande), which is broadly defined as extending from Cochiti Dam to Elephant Butte Reservoir. The actual Study Area encompasses a small portion of the Middle Rio Grande within the City of Albuquerque (COA), New Mexico. **Figure 1.1** shows the Study Area in the larger context of the State of New Mexico. The Study Area consists of 3.1 river miles along the Rio Grande stretching north and south from Central Avenue. Central Avenue is the longest intact segment of historic U.S. Route 66, which is the basis for the project's name.

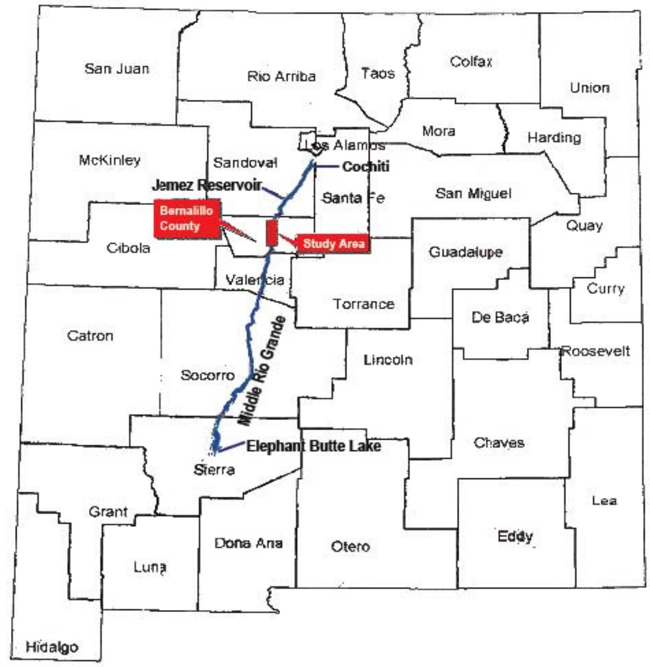


Figure 1.1 Locating the Study Area in New Mexico

Figure 1.2 Locating the Study Area in Albuquerque

The north side of the I-40 bridge is the upstream limit of the Study Area, and the south side of the Bridge Boulevard bridge is the downstream limit (see **Figure 1.2**). The Study Area is bounded on the east and west by the levees and riverside drains, except for a portion of the area north of the Central Avenue bridge on the west side where there is no levee or riverside drain and the boundary is the adjacent bluff.

The Study Area includes approximately 643 acres (260 hectares). There are 370 acres (150 hectares) within the active river channel and 273 acres (110 hectares) of riparian woodlands, or "bosque," as it is commonly referred to in New Mexico, (derived from the Spanish word for forest). With the exception of the northwest corner of the Study Area, the lands are managed by the MRGCD and the City of Albuquerque Parks and Recreation Open Space Division (AOSD) as part of the Rio Grande Valley State Park (RGVSP).

The MRGCD is the non-Federal sponsor for this Study. The MRGCD was established in 1925 to provide irrigation water, river flood control and soil drainage in the Middle Rio Grande Valley, primarily for agriculture. The MRGCD is based in Albuquerque, New Mexico with smaller facilities in other places along the Middle Rio Grande. The MRGCD manages most of the bosque and controls and maintains the system of canals, drainage ways and other facilities along the Middle Rio Grande from Cochiti Dam downstream to the northern boundary of Bosque del Apache National Wildlife Refuge. The AOSD, with whom the MRGCD co-manages the bosque within the Study Area, is a critical partner in the development and implementation of this plan. The AOSD manages 33,000 acres of land in the Albuquerque area, of which the bosque is the largest portion. The team responsible for the planning process (the Project Delivery Team) included representatives of the MRGCD, AOSD and New Mexico State Parks (NMSP) in addition to the Corps and their consultants.

Section 1135 project implementation requires the non-Federal Sponsor to provide 25 percent of the total project costs. In December 2001, the MRGCD signed a letter of intent to cost share the activities outlined in a jointly prepared Section 1135 Preliminary Restoration Plan. The Albuquerque District's Division Offices approved initiation of the present feasibility study on 23 January 2002. Cost-sharing requirements are discussed in detail in Section 5.7.

1.3 Background to the Study / Other Related Projects

River systems and their attendant wetland and riparian woodland communities provide significant resources for both wildlife and humans in the semi-arid western United States. Water resource management activities (for example, diversions, dams, levees, drains, channelization and jetty jack installation) by Federal agencies and other entities, as well as ongoing urbanization, have significantly altered the hydraulic function and ecological health of the Rio Grande within New Mexico. Jemez Canyon and Cochiti dams, operated for flood and sediment control by the Corps, also have contributed to degradation of ecosystem functions and values.

The Route 66 Project would extend previous efforts in this reach of the Rio Grande. These efforts date back to the 1920s and the founding of the MRGCD. At that time Aldo Leopold, a leading voice in the American Conservation Movement, and others considered the active Rio Grande floodplain and its attendant wetland and riparian woodland communities – the bosque – worthy of conservation. In 1983 the bosque within the boundaries of Bernalillo County was formerly designated as the Rio Grande Valley State Park. A memorandum of understanding between the NMSP, the City of Albuquerque and the MRGCD gave the AOSD primary management responsibility for the park's facilities, trails and lands. The AOSD and the Corps have undertaken most of the restoration efforts in the Study Area, including fire hazard mitigation, pole plantings of native trees, limited overbank projects and created wetlands.

In the late 1980s the Bosque Initiative was begun by representatives of management agencies, including the Corps. This interagency team drafted the Middle Rio Grande Bosque Biological Management Plan (1993) (MRGBBMP), a guiding document for all subsequent restoration projects in the Middle Rio Grande, including the current Study. Under the direction of the Bosque Improvement Group (BIG), the Bosque Initiative has continued to provide funding to a number of small research and restoration projects, including the Rio Grande Restoration site near the Tingley Ponds within the Study Area. Restoration efforts at a larger scale have been hampered by the limited resources available for such efforts. The fires in the summer of 2003 north of the I-40 bridge and near Montano, however, brought an added sense of urgency to commencing a larger-scale effort.

Corps projects currently underway in the area of the Middle Rio Grande bosque include a series of projects known as the Middle Rio Grande Restoration Projects. This initiative comprises four projects as follows: 1)

Albuquerque Bio-Park Tingley Ponds and Wetland Restoration, 2) Middle Rio Grande Bosque Restoration, 3) Ecosystem Revitalization @ Route 66, the subject of this report and 4) the Bosque Wildfire Project.

The first of these studies, the Albuquerque Biological Park Tingley Ponds and Wetlands Restoration Project (Bio-Park Project), is a Section 1135 Feasibility Study undertaken by the Corps at the request of the City of Albuquerque in 2001 to determine the advisability of rehabilitating the ponds at Tingley Beach and constructing a series of new wetlands within the adjacent bosque. The City of Albuquerque, through the Albuquerque Biological Park, is the non-Federal Sponsor for this project. The report and environmental assessment for the Bio-Park Project was completed in February 2004. The project's goal is to increase the acreage, quality and diversity of aquatic habitat in Tingley Ponds and constructing a wetlands complex in the adjacent bosque. The Corps completed the construction of the project in the fall of 2005.

The second of these studies, the Middle Rio Grande Bosque Restoration Study, is a Feasibility Study (the Bosque Restoration Project). It was initiated in Spring 2002 to determine if there is a Federal interest in restoring the Rio Grande Bosque in the vicinity of Albuquerque, New Mexico. The Study Area of the Bosque Restoration Project roughly corresponds to the boundaries of the Rio Grande Valley State Park. The local sponsor for this project is the Middle Rio Grande Conservancy District (MRGCD). The authorization for the Reconnaissance Phase of this study is contained in U.S. House of Representatives Resolution 107-258 for fiscal year 2002. On July 28, 2002, the Reconnaissance Report for this study was approved at the Headquarters of the Corps in Washington, D.C. for funding by Congress. The planning process included considerable community and stakeholder input in developing overall goals, objectives and concepts for future restoration efforts. These concepts were summarized in the Middle Rio Grande Bosque Restoration Supplemental Planning Information Document, which was completed in Summer 2003. The feasibility phase for the Bosque Restoration Study began in 2005, and is proposed to be complete in 2009.

The third and present Study is the Ecosystem Revitalization @ Route 66 Project. The Study began at the end of 2002. The area encompassed by the Route 66 Project is probably the most intensively used area of the bosque within the Middle Rio Grande reach and was identified as a high priority restoration area in the Bosque Restoration Study. The Route 66 Project has incorporated concepts and community input developed during the Bosque Restoration Study. The implementation of the Study would, in turn, provide important guidance for the feasibility phase of the Bosque Restoration Study.

The fourth study is the Bosque Wildfire Project which began in the Spring of 2004 in response to the bosque fires in Summer 2003. The project would reduce the probability of catastrophic fire through removal of access obstacles and increasing the number of access points. The draft environmental assessment was released to the public in July 2004 and was finalized in September 2004. Work has continued each year since 2004 completing over 500 acres of fuel reduction, removing over 3000 jetty jacks, installing 4 emergency access bridges across the Riverside Drain and revegetating all areas worked in.

In addition to these projects, there are several other Corps projects that affect the planning in the Route 66 Project. The Corps, in conjunction with the U.S. Bureau of Reclamation (USBOR) and the New Mexico Interstate Stream Commission (NMISC) is engaged in the Upper Rio Grande Water Operations and Procedures Study (URGWOPS). URGWOPS is providing important parameters for the restoration efforts contemplated in this study, such as baseline vegetation and hydraulic data. The Middle Rio Grande Endangered Species Act Collaborative Program (MRGESCP), in which the Corps is also a participant, is responsible for funding much of the ongoing research and restoration efforts in the Middle Rio Grande to enhance habitat for endangered species. The MRGESCP and URGWOPS, as well as researchers at the University of New Mexico (UNM), have provided important input for the study.

A number of MRGESCP projects have been constructed in the Albuquerque Reach. The Rio Grande Silvery Minnow Sanctuary was constructed by the BOR. This project constructed a sanctuary near downtown Albuquerque in the bosque that would contribute to the enhancement and recovery of Rio Grande silvery minnow (RGSM) in the Middle Rio Grande. This project is documented in the "Rio Grande Silvery Minnow Sanctuary Environmental Assessment – FINAL, November 2005" (BOR, 2005). The Middle Rio Grande Riverine Habitat Restoration Project has been conducted by the NMISC. This project is another MRGESCP project where the ISC is restoring aquatic habitat for the benefit of the RGSM in the river in the Albuquerque Reach by manipulating islands, bars and banks to mobilize sediments. This project constructed potential RGSM habitat on a riverine bar just south of I-40 on the east side of the river and just north of Central Avenue on the east side of the river (both sites are within the Study Area). This project is documented in the "Middle Rio Grande Riverine Habitat Restoration Project Environmental Assessment, March 2005" (ISC and BOR, 2005).

Other projects undertaken by the Corps in alliance with local sponsors at Los Lunas and the Pueblo of Santa Ana have provided important planning and restoration precedents. The Route 66 Project provides an opportunity to apply much of what has been learned in all of these projects and studies to a comprehensive, large-scale restoration project with high visibility in the community.

1.4 Resource Significance

The uniqueness of the Rio Grande system and its critical value as wildlife habitat make it of the utmost significance as a resource. As is suggested by the ongoing efforts described previously, the Rio Grande bosque is one of the most important and threatened ecosystems in the Southwest. The bosque is unique; it is a thin line of significant riparian habitat in an arid landscape of the Southwest. The Rio Grande was listed as one of the World Wildlife Fund's 10 most endangered rivers in the world in 2007. The habitat quality, although diminished over the past few decades, still remains one of the most significant in the region. Over 300 species of birds, mammals, amphibians and reptiles live in the bosque, which are more than double those found in any other major ecosystem in the State. In addition to the indigenous wildlife species mentioned above, the bosque serves as a migration route for thousands of North American birds moving along the Central Flyway. Southwestern riparian ecosystems are one of the most threatened bird habitats according to the American Bird Conservancy.

Functional riparian systems such as the Middle Rio Grande bosque are becoming increasingly rare in the Southwest. Such systems found in the heart of an urban area are rarer still. The Rio Grande with its bosque is a green ribbon that weaves together different communities of the Albuquerque metropolitan area both figuratively and physically, connecting the present-day urbanites to the original inhabitants in the region. For decades the bosque has provided ecosystem services (for example, water filtration, urban heat island mitigation, etc.) for Albuquerque and its neighboring communities. It also continues to provide unique aesthetic, cultural, educational and recreational opportunities for citizens and visitors to the region. The health of the region's many species of wildlife, as well as its human inhabitants, rests on the long-term health and viability of the Rio Grande bosque. The Middle Rio Grande is also the only habitat left (7% of the former range) for the Rio Grande silvery minnow and without restoration of nursery habitat, extinction is possible.

1.5 Planning Process

Development of the Route 66 Project Detailed Project Report and Environmental Assessment (DPR/EA) follows the Corps six-step planning process specified in Engineering Regulation (ER) 1105-2-100. These steps include 1) identifying problems and opportunities, 2) inventorying and forecasting conditions, 3) formulating alternative plans, 4) evaluating alternative plans, 5) comparing alternative plans, and 6) selecting a plan. This process is used to identify and respond to problems and opportunities associated with the Federal objective and specific State and local stakeholder concerns.

As part of identifying the Preferred Alternative, a number of alternative plans were developed by the Project Delivery Team and compared with the "no action alternative," allowing for the ultimate identification of the Recommended Plan or National Ecosystem Restoration (NER) Plan. The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost-effectiveness and incremental cost of implementing other restoration options. In addition to considering the system benefits and costs, it would consider information that cannot be quantified, such as environmental significance and scarcity, socioeconomic impacts and historic properties information. For project elements other than those specifically related to ecosystem restoration, such as educational and recreational plans, benefit-cost analysis from the National Economic Development (NED) planning process was used.

The report is organized to follow the planning process. Section I includes problems and opportunities. Sections II and III contain the inventory and forecast of resource conditions. Section IV describes the formulation, evaluations and comparisons of alternative plans. Section V presents a description of the recommended plan, and Section VI discusses the evaluation of impacts required by National Environmental Protection Act (NEPA). In addition, the report is structured to incorporate the Environmental Assessment required under NEPA.

1.6 Problems and Opportunities

Along the approximately three (3) miles of the Rio Grande within the Albuquerque area from Interstate 40 to Bridge Boulevard, the following problems and opportunities have been identified:

- The past water management operations and flood control measures, including levees, jetty jacks and upstream dams, have eliminated the historic broad, meandering channel and the flood regime that had resulted in periodic inundation of the bosque. Even with these limitations, however, there is an opportunity to re-create some limited hydraulic connectivity between the bosque and the river by enhancing existing high-flow side channels, excavating swales, constructing wet habitat and other interventions.

- The loss of wetlands, braided channels and backwaters has reduced the extent and quality of aquatic habitat and the potential for aquifer recharge. There is an opportunity to restore and create new wet habitat, which would improve habitat and recharge potential, as well as provide storm water filtration.

- The lack of inundation, scouring and sediment deposition within the bosque has curtailed native tree species such as cottonwood and willow seedling recruitment, increased the mortality rate of cottonwoods and willows, and resulted in significant leaf litter and dead and down wood, as well as a skewed age structure in the remaining cottonwood stands. There is an opportunity to remove dead and down wood and create new areas for colonization or planting of native vegetation.

- Human uses in the bosque connected to urbanization in areas outside the levees have further degraded the bosque through widespread dumping, accidental fires and high-impact recreational uses. There is an opportunity to clean up and revegetate these sites, as well as limit access and structure human use and experience of the bosque through well-developed trails and interpretive signage.

- The cumulative impact of the loss of inundation, the lower water table, cottonwood mortality and urbanization has led to the replacement of the mosaic of native woodlands and wetlands in many parts of the Study Area by dense stands of non-native salt cedar, Russian olive, Siberian elm, tree of heaven and white mulberry trees. There is an opportunity to remove non-native plants and revegetate with a variety of native plants, thereby improving habitat.

- The strings of jetty jacks and altered vegetation structure of the bosque have increased the potential for a catastrophic fire in the bosque. The density of the brush and existing jetty jacks can also make fighting a fire difficult and potentially dangerous. An opportunity exists to remove some of the jetty jacks and much of the vegetation that has created the existing fire hazard.

- The change from a mosaic of native plant communities of various structures and ages to increasingly large stands of non-native forest has affected the overall value of aquatic and terrestrial wildlife habitat provided by the bosque. There is an opportunity to rehabilitate the existing bosque into a dynamic mosaic of native vegetation patches of various ages, structure types and constituent species.

- The degradation of the bosque ecosystem has impaired interpretive, educational and recreational uses of the bosque in one of the most heavily used segments of the RGVSP. There is an opportunity to develop existing trails into a highly educational, aesthetically pleasing and safe interpretive system that furthers the overall goal of restoration.

1.7 Regulatory Compliance

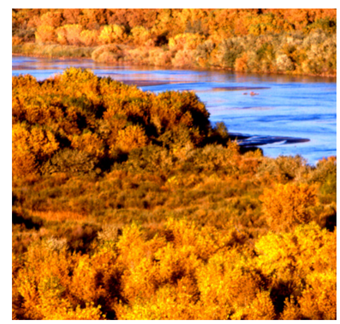
This document was prepared by the U.S. Army Corps of Engineers, Albuquerque District in compliance with all applicable Federal statutes, regulations, and Executive Orders, including the following:

- Clean Air Act of 1972, as amended (42 U.S.C. 7401 *et seq*.)
- Clean Water Act of 1972, as amended (33 U.S.C. 1251 *et seq*.)
- Endangered Species Act of 1973, (ESA) as amended (16 U.S.C. 1531 *et seq*.)
- National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq*.)
- Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, amended by Superfund Amendments and Reauthorization Act (SARA) in 1986, 42 USC 9601 et seq.
- Resource Conservation and Recovery Act (RCRA) of 1976, amended by Hazardous and Solid Waster Amendments in 1984, 42 USC 6901 et seq.
- Corps of Engineers Procedures for Implementing NEPA (33 CFR 230; ER 200-2-2)
- Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq.*)
- Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Order 12898)
- Farmland Protection Policy Act (P.L. 97-90)
- Floodplain Management (Executive Order 11988)
- Protection of Wetlands (Executive Order 11990)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. 470a *et seq*)
- Protection of Historic and Cultural Properties (36 CFR 800 *et seq*)
- Protection and Enhancement of the Cultural Environment (Executive Order 11593)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq*)
- Archeological Resources Protection Act of 1979 (16 U.S.C. 470)
- Federal Weed Act of 1974 (Public Law 93-269; 7 U.S.C. 2801, *et seq*.)

- Migratory Bird Treaty Act of 1918 (16 U.S.C 703, *et seq*.)
- Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq*.)

This document also reflects compliance with all applicable tribal, State of New Mexico and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources.

Section 2 Existing Environmental Setting



2.1 Geology, Soils and Climate

The Study Area is situated in the Albuquerque Basin of the Rio Grande Rift Valley (Crawford et al. 1993) (**Figure 2.1**). The valley formed as crustal tension beginning in the Tertiary Period (ca. 35 million years ago) along the Rio Grande Rift created a series of fault-bordered valleys, including the Albuquerque Basin. Volcanism and erosion from adjacent uplands filled the valley with thousands of feet of alluvial sediments, lava, and ash (Chronic 1987). The current floodplain of the Rio Grande in the Study Area consists of fine-grained alluvial silts, sands, and gravels. Soils derived from these deposits in the Study Area are Torrifluvents, Calciorthids and Torriorthents (Soil Conservation Service 1974).

Elevation in the Study Area ranges from 4,950 feet to 5,050 feet above mean sea level. Climate data recorded from 1914 through 2001 at the Albuquerque Airport (Station No. 290234) and from 1924 through 1982 at Bernalillo (Station No. 290903) are summarized in **Table 2.1** (Western Regional Climate Center 2003). Average total annual precipitation at the Albuquerque Airport is 8.70 inches and average annual snowfall is about 10.4 inches. Average total annual precipitation at Bernalillo is 8.86 inches and average annual snowfall is about 6.9 inches.

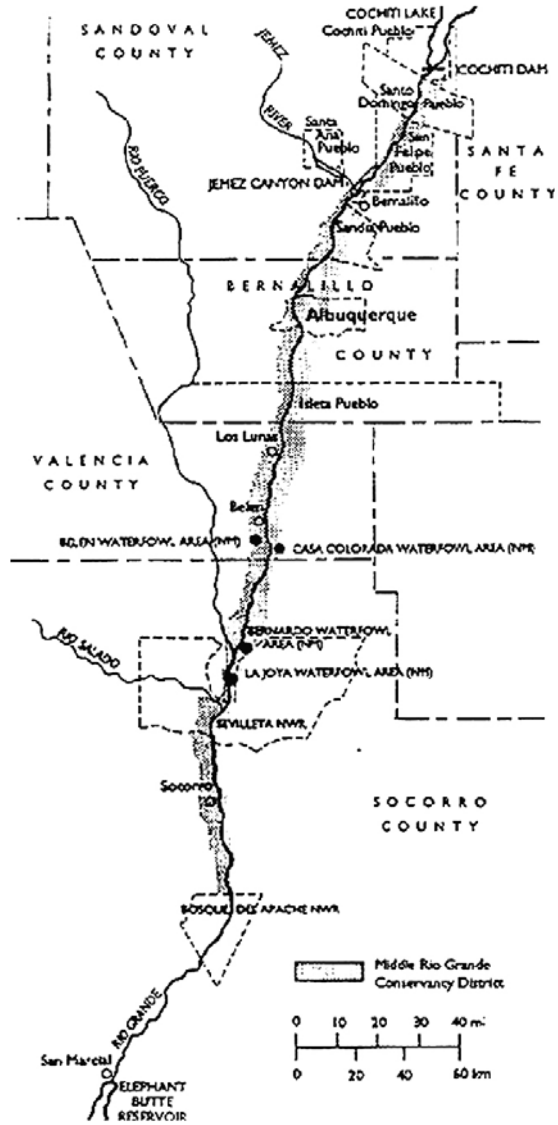


Figure 2.1 Middle Rio Grande

Table 2.1 Weather Data from Albuquerque (ABQ) and Bernalillo (BERN)

	Winter		Spring		Summer		Fall	
	ABQ	BERN	ABQ	BERN	ABQ	BERN	ABQ	BERN
Maximum Temp	49.4° F	51.6° F	70.0° F	72.2° F	90.0° F	92.2° F	70.1° F	72.6° F
Minimum Temp	25.0° F	20.1° F	41.1° F	35.3° F	62.1° F	55.9° F	43.7° F	37.2° F
Average Precipitation	1.23 in	1.42 in	1.68 in	1.70 in	3.49 in	3.43 in	2.29 in	2.32 in

2.2 Hydrology, Hydraulics and Sediment Continuity Analysis

2.2.1 History

The river morphology of the Middle Rio Grande was once that of a wide, shallow braided channel characterized by high sediment loads and frequent flood events (USACE 2003). The channel over the last several hundred years has moved across or flooded in its entirety what is now the 500-year flood zone as shown in Figure 2.1. Today, the Rio Grande in the Albuquerque area is no longer a braided channel nor is the river able to meander across the original floodplain.

The Rio Grande is now confined as a result of the many water resource activities previously described and by the construction of the Albuquerque Levees Projects built in the mid 1950's and the Corrales Levee Project built in 1996. The hydrologic cycle in the Middle Rio Grande Valley (delineated as Cochiti Lake to Elephant Butte Lake) is critical to the function of the bosque cottonwood riparian communities and wetlands. It follows a pattern of high flows during spring snowmelt runoff and low flows during the fall and winter months. Additional high flows of short duration result from thunderstorms that occur in the late summer months.

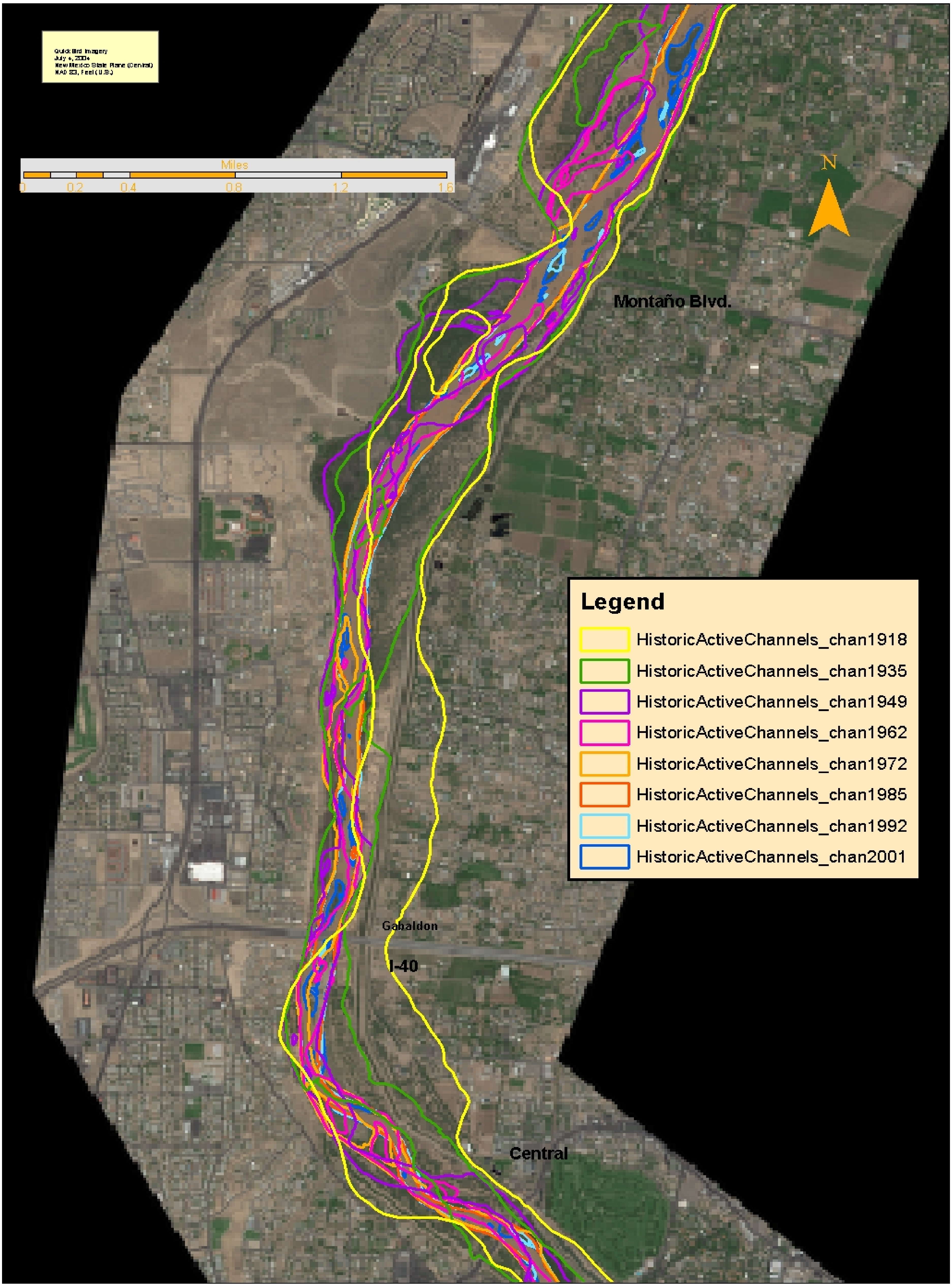
2.2.1.1 Effect of Regulated Flow on the Study Reach

The Middle Rio Grande hydrology has been altered dramatically by flood control dams. Historic annual peak discharges have changed from peak flows of over 20,000 cubic feet per second (cfs) prior to World War II to peak flows of less than 10,000 cfs after the construction of Cochiti Dam in 1973. The post Cochiti average annual peak discharge has been affected as well and will be discussed in more detail later in this text.

The change in seasonal discharges has also impacted channel-forming processes. Discharge is the dominant variable that affects channel morphology, but sediment transport, channel bed & bank material and other hydraulic factors are also important influences. Historically, the wide shallow channel was described as a sand-bed stream (Nordin and Beverage 1965) with a braided pattern (Lane and Borland 1953) likely resulting from sediment overload (Woodson 1961). The river followed a pattern of scouring and filling during floods and was in an aggrading regime (accumulating sediment). Flood hazards associated with the aggrading riverbed prompted the building of levees along the floodway. However, the levee system confined the sediment and increased the rate of aggradation in the floodway. Additionally, channel stabilization works which included jetty jacks installed during the 1950s and 1960s contributed to building up and stabilizing the over-bank areas where the bosque currently exists. Construction of dams at Jemez Canyon (1953), Abiquiu (1963), Galisteo Creek (1970), and Cochiti (1973) were expected to slow aggradation or reverse the trend and promote degradation in the Middle Rio Grande Valley. The flood control improvements have reduced the sediment load in the Middle Rio Grande and accomplished flood control objectives for much of the river valley. This has caused changes in the geomorphology of the Rio Grande through the Albuquerque reach and affected the conveyance capacity of the active river channel. The result of these changes has been a reduction in the frequency of over-banking flows into the Rio Grande Bosque.

Figure 2.2
Middle Rio Grande - Albuquerque Reach
Channel Change, 1918-2001

May 6, 2005



In June 2006, the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) prepared a report for the Albuquerque District U.S. Army Corps of Engineers entitled, “Middle Rio Grande Flow Frequency Study” (HEC Report – see Technical Appendix F). The purpose of this study was to develop a flow frequency curve for the Rio Grande at Albuquerque.

In order to develop unregulated volume frequency curves, unregulated daily flows were needed for the Rio Grande, the Rio Chama, and the Jemez River. The Rio Chama and Middle Rio Grande contain a number of reservoirs: El Vado, Abiquiu, and Cochiti. Reservoirs have also been constructed on tributaries flowing into the Rio Grande, such as the Jemez Canyon Dam on the Jemez River. The development of the unregulated flow time-series removed effects caused by the reservoirs on the flow time-series at Albuquerque.

Cochiti Dam began regulating flow on the Rio Grande in 1974. Table 2.2 is provided to demonstrate the effects of regulation at Albuquerque for the post-Cochiti Dam period. The table gives a comparison of daily average peak flow for the “Rio Grande at Albuquerque” gage versus unregulated daily average peak flows for Albuquerque given in the HEC Report. Only floods generated by snowmelt and rainfall upstream of the reservoirs were included in this comparison. All flows are given in cubic feet per second (cfs).

Table 2.2 Comparison of Daily Average Peak Flows for the Gage at Albuquerque

Year	Daily Average Peak Flow (in cfs)	Unregulated Daily Average Peak Flow (in cfs)
1975	5800	8848
1976	3170	4103
1978	4320	5528
1979	7870	15873
1980	7130	11023
1982	4620	6680
1983	6970	11965
1984	8260	13433
1985	8650	16503
1986	4490	8052
1987	5990	10881
1989	3670	4798
1992	5360	7916

1993	6960	10314
1994	5230	10070
1995	6370	9413
1997	5430	8171
1998	3940	4708
1999	4520	6018
2001	4730	5528

Table 2.2 indicates that were it not for the regulation of upstream flows, the Rio Grande at the Albuquerque gage would have experienced spring flows of 10,000 cfs or greater a total of eight (8) times between 1975 and 2001. This is consistent with the pre-Cochiti Dam flow record which shows that from 1942 to 1973 spring flows reached or exceeded 10,000 cfs a total of seven (7) times at the Albuquerque gage. The gage record shows that flows of 10,000 cfs or greater were never reached at the Albuquerque gage during the post-Cochiti Dam period (1974 to present). The results of the HEC Report show that flow releases from Cochiti Dam can be regulated to 7,000 cfs for flows generated by snowmelt and rainfall upstream of the reservoirs for any event up to the 200 year frequency event. In the 200 year frequency event the HEC Report predicts a spillway flow resulting in a total combined discharge of 10,000 cfs.

For comparative purposes, **Figure 2.3**, below shows the 1987 hydrograph taken from the gage record:

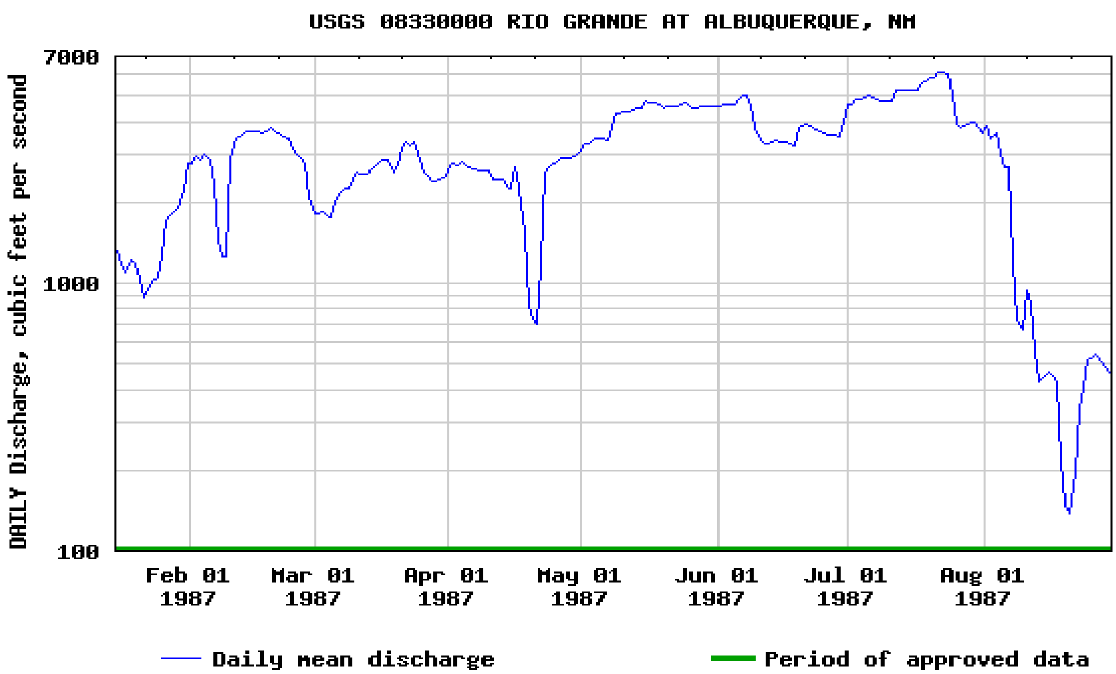


Figure 2.3 - 1987 Hydrograph for USGS Gage at Albuquerque

From the FLO-2D analysis for this study, as described in the following Section 2.2.2, it is unlikely that significant overbank flow would be experienced if this hydrograph were to occur under the existing conditions. In fact, the spring 2005 hydrograph was similar in peak flow and resulted in relatively limited overbank flows. The 2005 hydrograph is shown below in **Figure 2.4**:

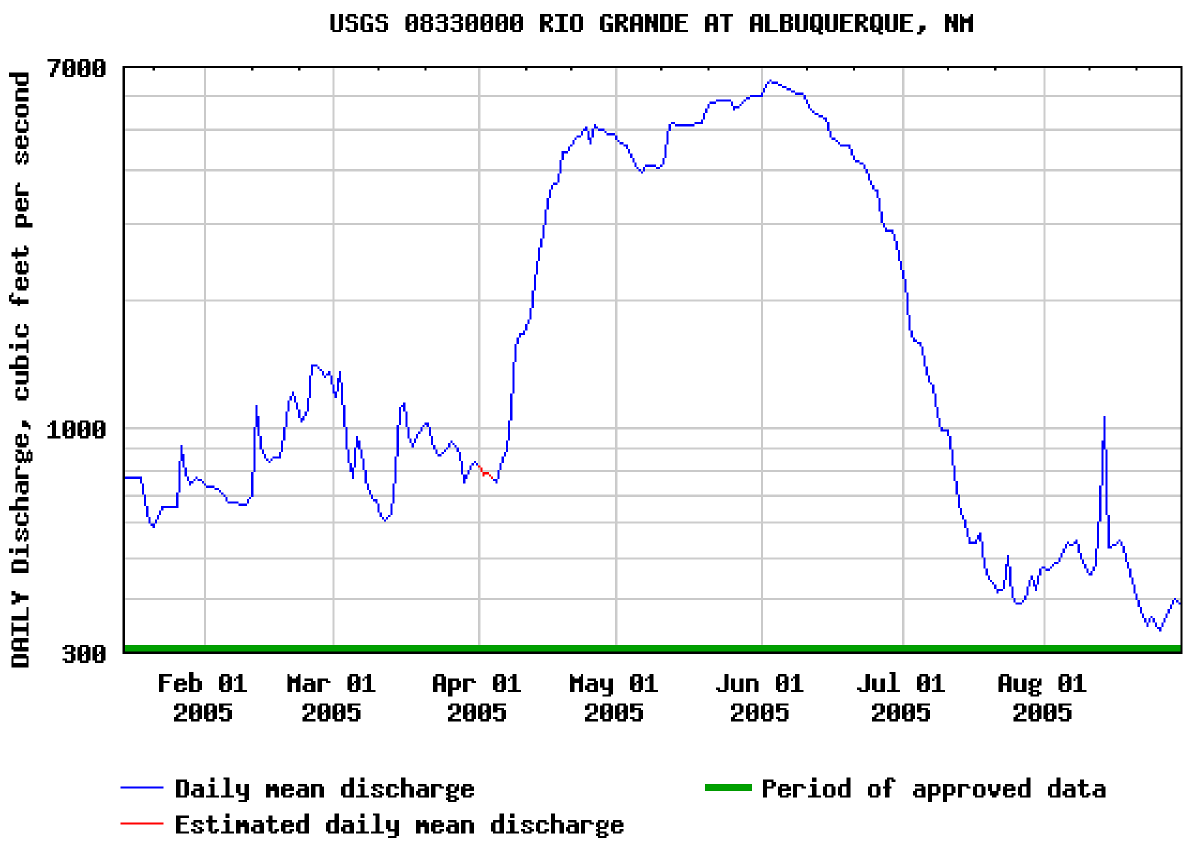


Figure 2.4 - 2005 Hydrograph for USGS Gage at Albuquerque

According to Table 2.2 above, the unregulated flow for 1987 would have been 10881 cfs. This would perhaps be comparable to the 1949 hydrograph with a peak daily flow of 10556 cfs. This flow rate could cause widespread overbank flows through the Rio Grande bosque under existing conditions based on the results from the FLO-2D analysis. The 1949 hydrograph is shown in **Figure 2.5**, below:

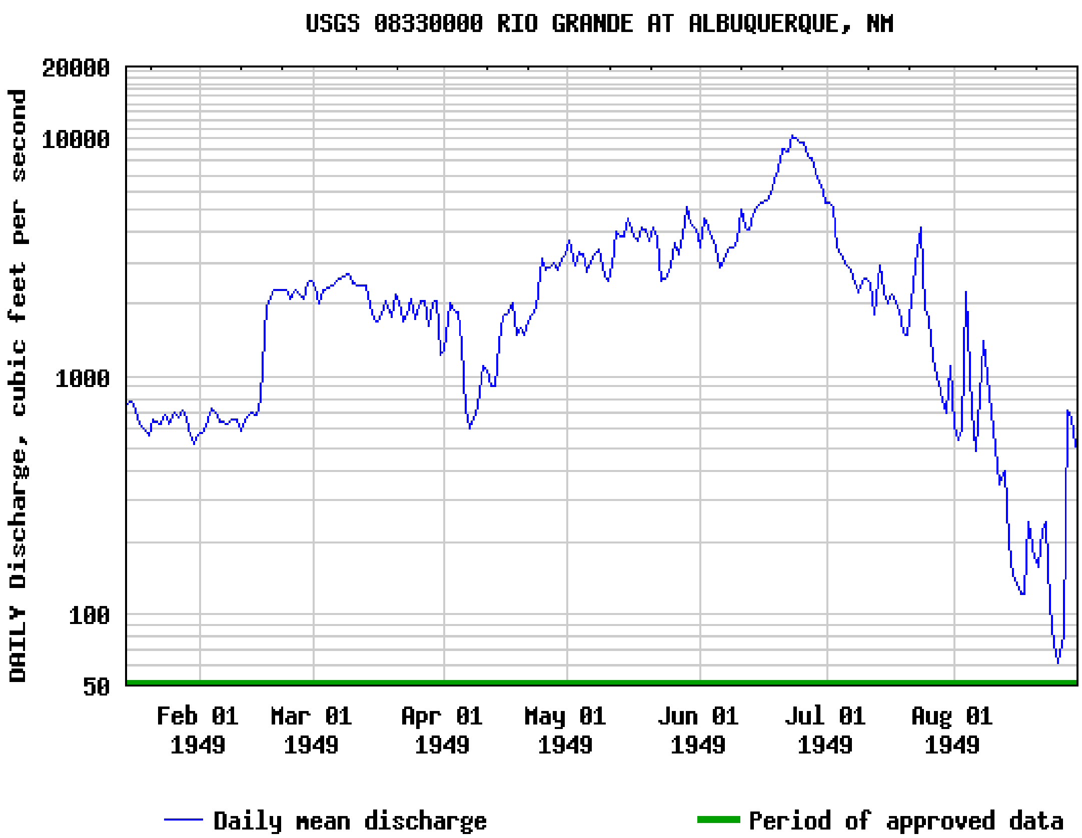


Figure 2.5 - 1949 Hydrograph for USGS Gage at Albuquerque

When the results of the HEC Report are combined with the results of the FLO-2D analysis for this study as described in the following Section 2.2.2, evidence is provided that watershed regulation has significantly reduced overbank flows throughout the study reach. This is also consistent with observations made during recently occurring high flow events through the study reach.

2.2.2 Hydraulics

2.2.2.1 Introduction of Analysis

Mussetter Engineering, Inc. (MEI) was retained by the Corps (Contract DACW47-02-D-005, Delivery Order 0006) to perform FLO-2D modeling to support a planning study of the Albuquerque Reach of the Rio Grande, which extends from the Corrales Siphon to the northern boundary of the Pueblo of Isleta (**Figure 2.6**). The objective of the planning study is to increase river channel bosque overbank connectivity, produce enhanced cover and aquatic habitat diversity, restore healthy riparian function to enhance natural riverine processes and improve terrestrial wildlife habitat, protect existing structural features such as pipelines, bridges and levees with a preference toward using bank biostabilization techniques when structures are found to be at risk from natural geomorphic processes (USACE, 2004). The FLO-2D modeling provides an assessment of overbank flows, storage, and hydraulic data to facilitate analysis of sediment-transport conditions and geomorphic processes along the reach. These results will then be used to evaluate various restoration alternatives (Section 6.5.2).

The hydraulic modeling report prepared by MEI summarizes the analysis of the baseline conditions, which is the first phase of the modeling project under this task order. The analysis included (1) development of the hydrologic scenarios, (2) FLO-2D model development, model verification and application, and (3) a baseline channel-stability analysis. The report is entitled, "FLO-2D Model Development, Albuquerque Reach, Rio Grande, NM" by Mussetter Engineering, Inc. dated January 24, 2006 (MEI Report). This report is included in Technical Appendix F and provides the results of the detailed analysis.

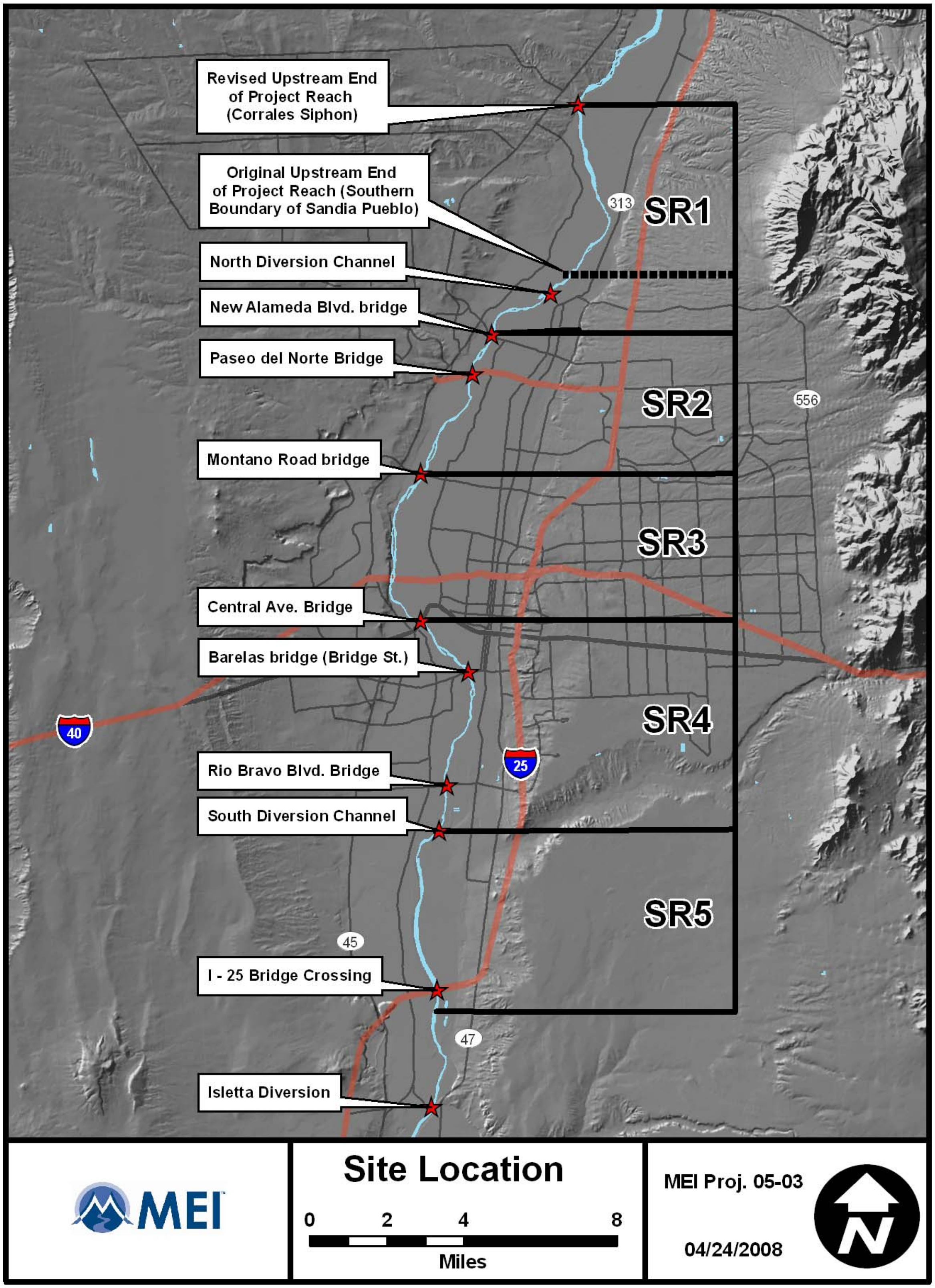


Figure 2.6. Location map showing the project reach and subreach boundaries.

2.2.2.2 The FLO-2D Model

The FLO-2D Model is a two-dimensional hydraulic model that estimates routing of one or more inflows over a grid system representing the floodplain. It includes a one-dimensional hydraulic model for channels. FLO-2D uses volume conservation and the momentum equation as the basis for a time sequence simulation model of unconfined flows. Channel and floodplain flows are calculated using standard hydraulic parameters. FLO-2D can be applied to analyze split channel flows, sediment movement, mud and debris flows, and flows over alluvial fans. A detailed FLO-2D model could simulate rainfall and infiltration, and flows with respect to levees, hydraulic structures, streets, buildings and flow obstructions.

FLO-2D numerically routes one or more hydrographs that can be introduced to the channel or floodplain at any location and at any time in the simulation. It accounts for tributary flow and interaction of high flows with the other flows in the system. FLO-2D provides an estimate for hydraulic parameters such as flow depth, velocity and area of inundation. The model is an effective tool for predicting channel and overbank flow.

The FLO-2D model of the channel-floodplain interface provides for flow exchange in both directions based on the difference in water surface elevations. The diffusive wave equation and the floodplain roughness are the basis of the computation. The elevation of the channel bank is found in the channel cross-section data. In order to prevent numeric surging, FLO-2D balances the relationship between slope, flow area and roughness throughout the simulation. Internal to the calculation, Manning's n is adjusted accordingly. These adjustments are explained in the "FLO-2D User's Manual".

The Grid Developer System (GDS) is a FLO-2D preprocessor that generates the FLO-2D grid. It uses a set of digital terrain model (DTM) points, overlays the grid onto the DTM, interpolates and assigns elevations to each grid element. A statistical distribution of random elevation points is generated for each grid elements. A data filter can be used to eliminate points that would distort the average elevation, such as elevations of treetops and rooftops. The elevation is then calculated using inverse weighted distance averaging.

The "FLO-2D User's Manual" provides an explanation of the governing equations, model logic, limits and assumptions, as well as application of specific model components.

2.2.2.3 The Middle Rio Grande FLO-2D Flood Routing Model

A FLO-2D model of the Rio Grande was developed and calibrated as part of an interagency project, the Upper Rio Grande Watershed Operations Review (URGWOPs). The Albuquerque District of the Corps of Engineers is one of the participating Federal agencies in the URGWOPs project. The URGWOPs FLO-2D model extends from Cochiti Dam downstream through the project area.

The URGWOPs model was ideal as the basis for a flow routing model for the study area. It uses the following base data:

- A 500-ft grid system with elevations from various sources. In the project area the majority of the elevations were developed from Bernalillo County Digital Mapping Project 1999 - 2000. The vertical datum was converted from NGVD 29 to NAVD 88.
- Parameters related to the grid and channel system that were initially estimated based on engineering judgment. Channel roughness and infiltration have since been calibrated.
- Channel sections that have been surveyed over the past 5 years. Intermediate sections are interpolated from the surveyed sections.
- Levee elevation data obtained from surveys and DTMs.

"Development of the Middle Rio Grande FLO-2D Flood Routing Model Cochiti Dam to Elephant Butte Reservoir" is a 2004 report by Tetra Tech, Inc., that documents the URGWOPs model (Appendix A). It provides a description of the data used to develop the model, its components, and some of its applications.

The model was calibrated using 1997, 1998 and 2001 gage data and aerial photographs. Parameters that were adjusted include channel roughness and channel infiltration, in order to improve hydrograph timing, shape and volume. The calibration data did not represent a large flood event, since no high flows of significance have occurred in the past 30 years. The data that were used for calibration were gage data, since no high water marks were available. When more flood data become available, additional calibration will be done. Information about the model calibration is provided in a 2002 report titled "Development and Calibration of the Middle Rio Grande FLO-2D Flood Routing Model", by TetraTech, Inc. in Technical Appendix F.

A more recent version of the FLO-2D model was released in 2003, after the model calibrations described above were performed. It is the 2003 version of FLO-2D that was used for the hydrologic routing described in this report.

A second FLO-2D model was subsequently developed by Riada Engineering, Inc. and MEI (2008) for the Corps to update the initial URGWOPS model with a grid resolution of 250 feet. This model contains over 167,000 elements. Results from the existing conditions models were used to provide baseline conditions for comparison with results for the restoration alternatives. As a result, the Corps requested that existing conditions be re-evaluated using the 250-foot grid model over the extended reach for all four hydrology scenarios. The in-channel hydraulic results from the 250- and 500-foot grid models are very similar throughout the project reach. As a result, the channel stability analysis was not re-evaluated using the 250-foot grid.

The original upstream boundary of the project reach for the 500-foot grid model was located at the southern boundary of the Pueblo of Sandia. After completion of the initial report (MEI, 2005), the Corps requested that the upstream end of the project reach be moved approximately 5.3 miles upstream to the Corrales Siphon (opposite the Rio Rancho Wastewater Treatment Plant) to encompass all of the potential restoration alternatives (Figure 2.5).

The hydraulic modeling report prepared by MEI summarizes the analysis of the baseline conditions, which is the first phase of the modeling project under this task order. The analysis included (1) development of the hydrologic scenarios, (2) FLO-2D model development, model verification and application, and (3) a baseline channel-stability analysis. The report is entitled, "FLO-2D Model Development – Existing Conditions and Restoration Alternatives 1,2 and 3, Albuquerque Reach, New Mexico" by Mussetter Engineering, Inc. dated May, 2008. This report is included in Appendix A and provides the results of the detailed analysis described above.

A summary of results taken from the report are provided below. However, for a more detailed explanation and review of the results, refer to Appendix A.

2.2.3 Hydrology

The scope of this project specifies that the following four hydrologic events (or hydrologic scenarios) are to be modeled in evaluating baseline conditions and other project alternatives that will be developed as the project progresses:

The following four hydrologic scenarios (**Table 2.3**) were used to evaluate the baseline conditions:

Table 2.3. Summary of Hydrologic Scenarios.

Hydrologic Scenario	Description	Peak Discharge (cfs)
1	Active channel-full flow	6,000
2	Post-Cochiti annual spring hydrograph	3,770
3	10,000 cfs post-Cochiti hydrograph	10,000
4	100-year post-Cochiti hydrograph	7,750

2.2.3.1 The active channel-full flow, Hydrology Scenario 1

The active channel-full flow in this reach has been determined to be close to 6,000 cfs. This scenario was modeled as a steady-state condition, because the primary purpose is to evaluate the extent and location of overbank flooding that would occur under a sustained discharge at this level. This discharge has a peak flow recurrence interval of about 2.3 years, and mean daily flow exceedance probability of 1.2 percent (i.e., it occurs 4 to 5 days per year, on average).

2.2.3.2 A representative post-Cochiti annual spring runoff hydrograph, Hydrology Scenario 2

A representative post-Cochiti annual spring runoff hydrograph with a maximum mean-daily flow of 3,770 cfs was developed for evaluating the various riparian and wetland restoration alternatives. To develop the representative hydrograph, mean daily flow values for each of 29 post-Cochiti annual hydrographs were plotted.

Because the individual hydrographs peak at different times each year, the timing of each of the annual hydrographs was adjusted by centering the hydrographs so that the rising and falling limbs match as closely as possible to prevent over estimating the hydrograph volume, particularly on the rising and falling limbs. A 50-percent exceedance hydrograph was computed based on these translated hydrographs and yielded a peak discharge of 3,770 cfs (A log-Pearson

III frequency analysis of the annual peak flows that was performed for this evaluation indicates that the peak mean daily flow of 3,770 cfs shown in **Figure 2.7**, corresponds to a recurrence interval of about 1.4 years and a mean daily flow exceedance probability of 8.1 percent [i.e., occurs 30 days per year, on average]).

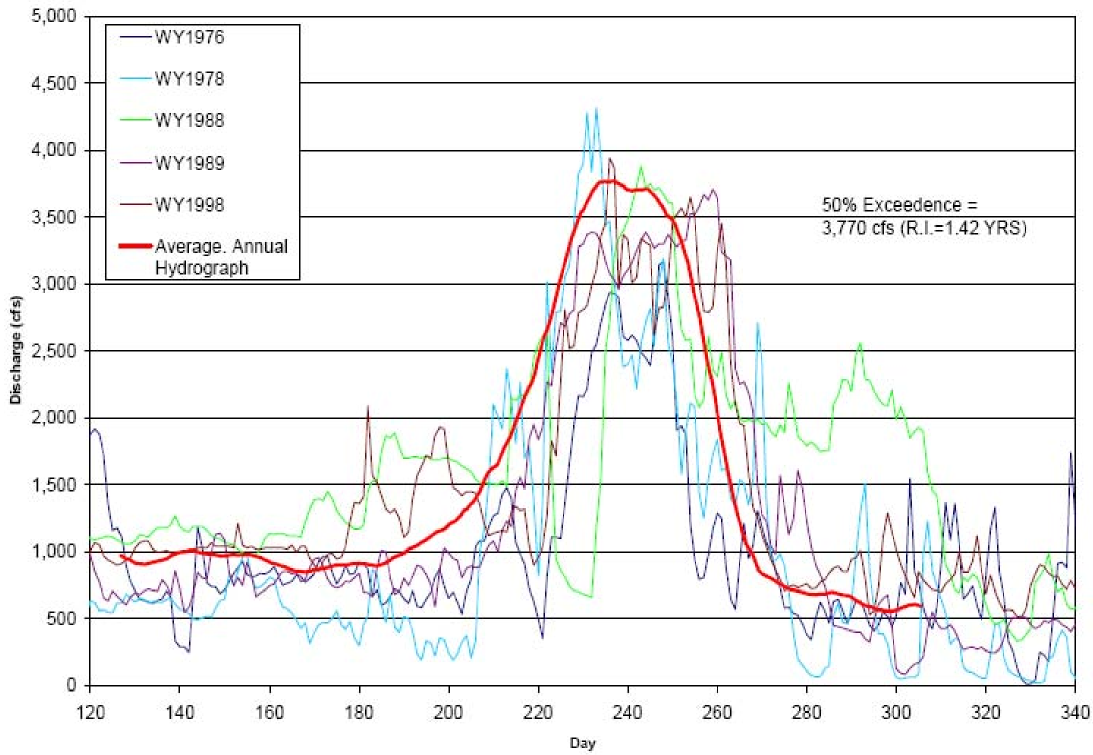


Figure 2.7 - The representative 50-percent exceedance hydrograph and a comparison with five natural hydrographs with similar peak discharges.

The mean daily flow hydrographs that were developed for this analysis primarily represent snowmelt runoff from the upper part of the basin which typically changes discharge relatively slowly due to the size of the drainage basin and dampening effects of the upstream reservoirs. As a result, the mean daily and instantaneous maximum flows during the snowmelt season are not significantly different; thus, the use of mean-daily flow values for this analysis is believed to be appropriate.

2.2.3.3 A 10,000-cfs post-Cochiti flow hydrograph, Hydrology Scenario 3

This hydrology scenario was modeled for the purpose of determining the effect of a high-flow release through the project area under existing conditions. The 10,000-cfs hydrograph was developed by scaling the ordinates of the 10-percent exceedance hydrograph (shown on **Figure 2.8**) to provide a peak discharge of 10,000 cfs, and then adjusting the duration to achieve the target volume of 1,467,000 ac-ft that was determined by extrapolating the best-fit curve in **Figure 2.9** to 10,000 cfs.

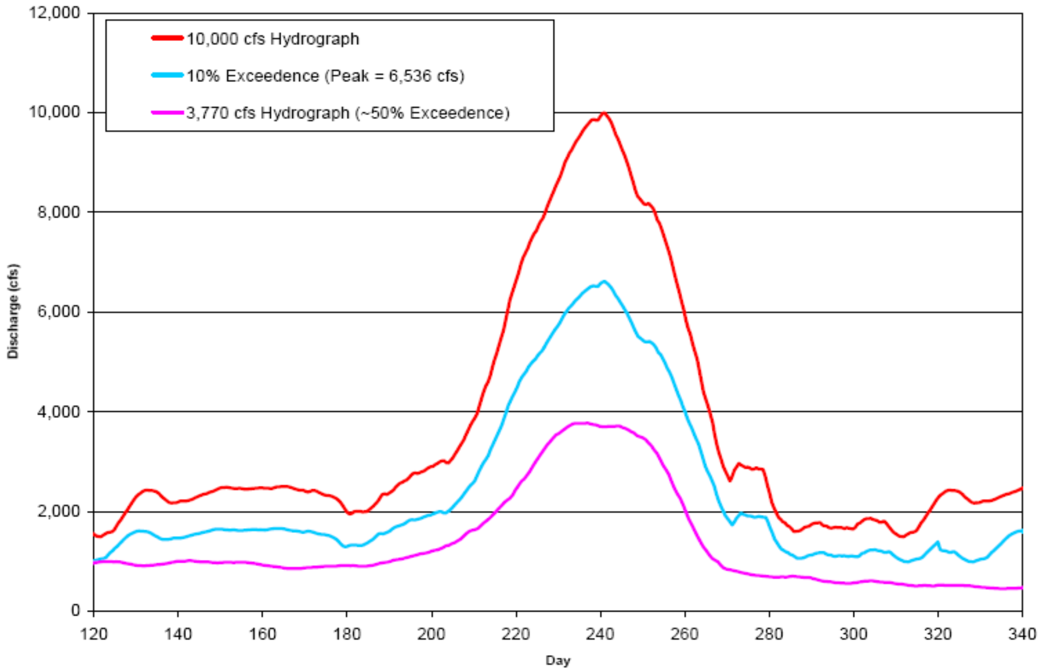


Figure 2.8 - Comparison of the 10,000-cfs hydrograph with the 10- and 50-percent exceedance hydrographs.

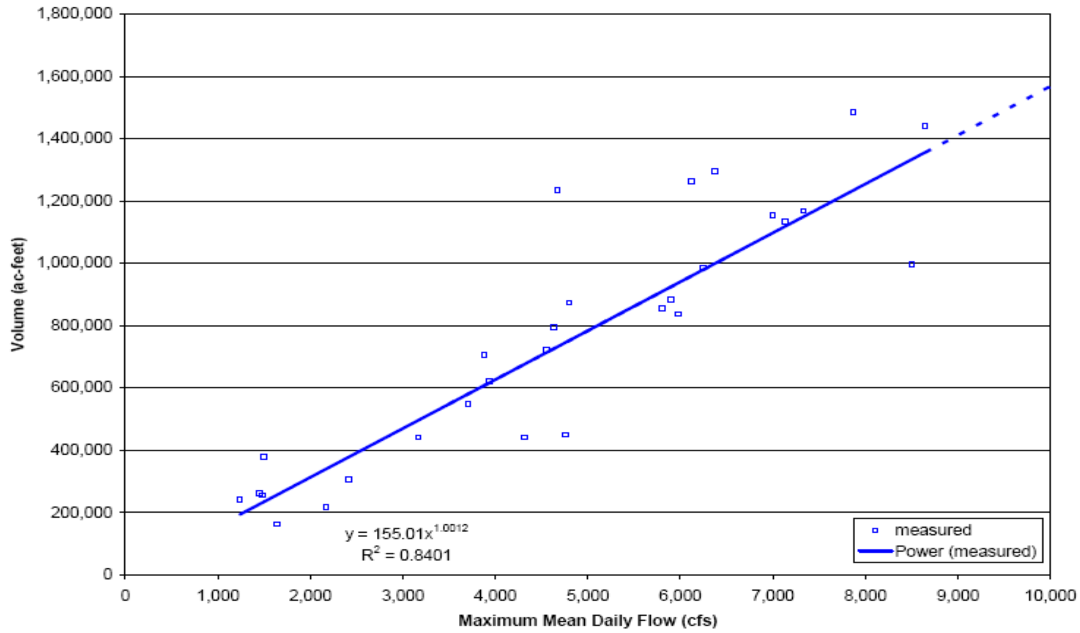


Figure 2.9 - Comparison of maximum annual mean daily flow values versus computed volumes during the runoff period or Water Year 1974 to Water Year 2002. The curve is extrapolated to 10,000 cfs using a power function.

In the development of the 50-percent exceedance hydrograph, the peak discharge was contained within the range of discharges and no scaling of the peak discharge was required. However, since the peak discharge of 10,000 cfs has not occurred during the post-Cochiti period, the 10-percent exceedance hydrograph was scaled, rather than the 50-percent hydrograph, because it provides a more realistic shape of the largest hydrographs.

2.2.3.4 The 100-year post-Cochiti flood-flow hydrograph, Hydrology Scenario 4

Analysis of the Rio Grande flood hydrology by the Hydrologic Engineering Center (HEC, 2006) indicated that the 100-year snow melt hydrograph (Scenario 4) has a peak discharge of approximately 7,750 cfs (**Figure 2.10**). This snowmelt hydrograph was developed by routing actual hydrographs from time-series analysis of unregulated flows through the upstream reservoirs using the ResSim model, and then routing the resulting outflow hydrographs from Cochiti Reservoir downstream through the project reach using the FLO-2D model. The snowmelt hydrograph has a duration of approximately 17 weeks, and is regulated by Cochiti

Dam at a relatively constant flow of about 7,000 cfs over most of the period. The hydrograph showing the effects of upstream regulation is shown in **Figure 2.10.**

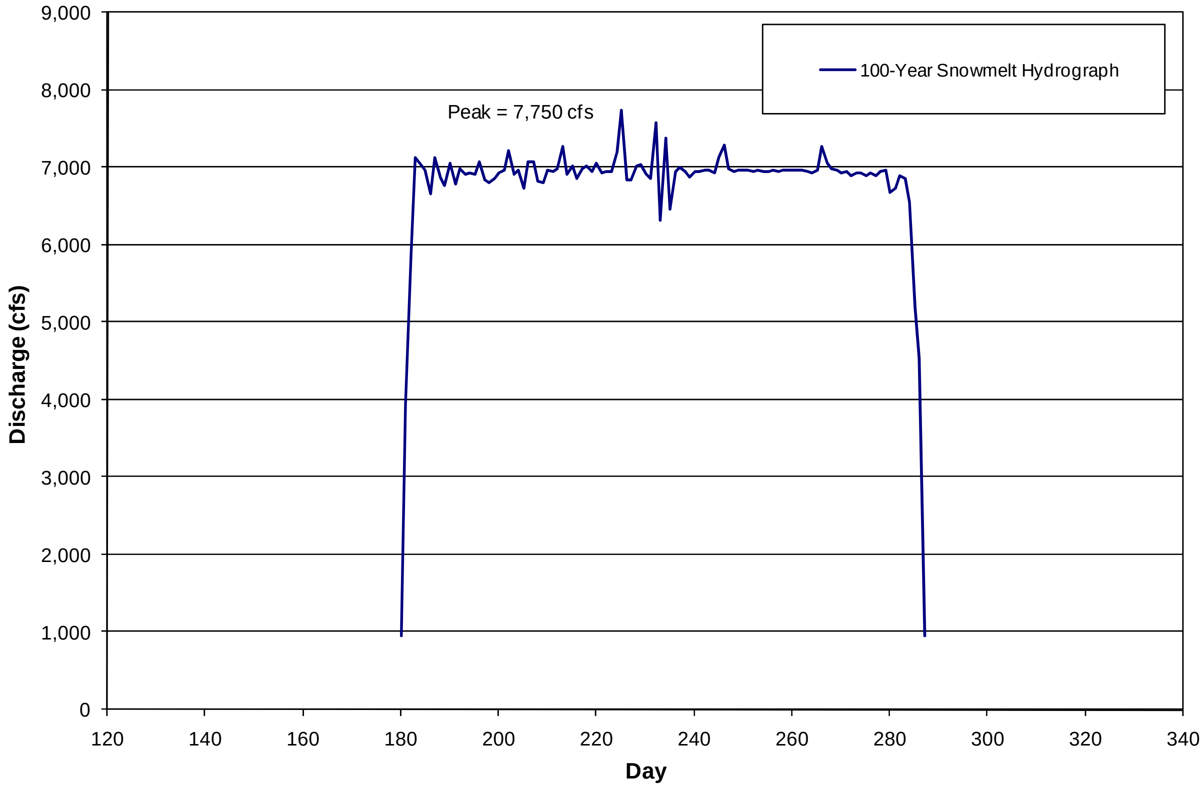


Figure 2.10 - The representative 100-year snowmelt hydrograph.

2.2.4 Hydraulics - Model Calibration and Validation

A detailed discussion of the model development, calibration and validation can be found in the report in Appendix A and will not be discussed in detail here. However, comparison of the predicted water-surface elevation at 6,300 cfs from the updated FLO-2D model with the 2005 measured profile shows very good agreement. The performance of the model was also evaluated over a broader range of flows and compared to water surface elevations at four bridges where measured water-surface elevations were available. Based on the results, the updated FLO-2D model appears to be reasonably well validated.

2.2.4.1 Hydraulics - Model Results (250-foot FLO-2D Model)

The validated Existing Conditions FLO-2D model was run for the four hydrology scenarios, and the results were used to compare the main channel water-surface elevations with the top-of-bank elevations and to map and evaluate the extent, depth and duration of overbank inundation along the reach (Technical Appendix F).

In the FLO-2D model, a representative elevation is assigned to each grid cell; thus, the local depth or duration of inundation at any point within the cell may vary from the representative value predicted by the model due to variations in the ground elevations. To provide a more detailed depiction of the variation in depth than is shown with the 250-foot grid spacing, a new water-surface DTM with 30-foot pixel resolution was developed based on maximum water-surface elevations predicted by the FLO-2D model for each simulation. The local depth within each 30-foot pixel was then determined by overlaying the water-surface DTM onto the detailed ground-surface DTM.

2.2.4.2 Existing Conditions: Hydrology Scenario 1 (Active Channel Full Flow)

Existing conditions results for the active channel-full flow hydrograph (Hydrology Scenario 1) indicate that the water-surface elevation is at or above the top of bank elevation at several locations along the project reach, including:

1. left bank, approximately 4,000 feet upstream from the Central Avenue Bridge (approximately midway between Central Avenue and I-40 Bridges)
2. extensively along the left and right banks from approximately 8,000 feet upstream from the Rio Bravo Bridge to just downstream from the Rio Bravo Bridge,
3. extensively along the left and right banks from approximately 7,000 feet downstream from the South Diversion Channel to just downstream from the I-25 Bridge.

Maps showing the extent of inundation for the channel-full conditions are provided in Appendix A. Inundation areas are color-coded with different shading in 1-foot increments to distinguish depths.

The amount of overbank inundation for channel-full flow conditions was summarized for each subreach based on the number of inundated grid elements computed in the FLO-2D simulation (**Table 2.4**). Table 2.4 indicates the amount of overbank inundation which occurs in each Subreach. Approximately 68.1 acres, 41.3 acres, 25.2 acres, 42.4 acres and 69.0 acres are inundated in Subreaches 1 through 5, respectively. The extent and maximum depth of inundation for this scenario is shown in Technical Appendix F.

Table 2.4. Summary of area of inundation for existing conditions (acres).

Hydrology Scenario	Description	Subreach					
		1	2	3	4	5	Total
1	Channel Full Conditions	68.1	41.3	25.2	42.4	69.0	246.0
2	Annual Spring Runoff	37.3	17.7	3.7	4.0	7.9	70.6
3	10,000 cfs hydrograph	181.9	125.6	82.2	233.7	412.9	1,036.3
4	100-year Peak Snowmelt	84.4	59.9	14.6	133.4	364.9	657.2

2.2.4.3 Existing Conditions: Hydrology Scenario 2 (Annual Spring Runoff Hydrograph)

The maximum computed water-surface elevations during the average annual hydrograph (Hydrology Scenario 2) indicate that the top-of-bank elevation is exceeded at several locations along the project reach but the overall area of inundation is small:

Approximately 37.3 acres, 17.7 acres, 3.7 acres, 4.0 acres and 7.9 acres are inundated in Subreaches 1 through 5, respectively. The extent, maximum depth and duration of inundation for this scenario are shown in the MEI Report in Technical Appendix F. Very little overbank inundation occurs under Hydrology Scenario 2, because the peak discharge of 3,770 cfs is substantially less than the channel capacity along the majority of the reach.

2.2.4.4 Existing Conditions: Hydrology Scenario 3 (10,000-cfs Hydrograph)

The maximum computed water-surface elevations during the 10,000 cfs snowmelt hydrograph (Hydrology Scenario 3) indicates that overbank inundation occurs at similar locations to the channel full condition, but with larger areas of inundation. Additional overbank inundation areas occur downstream from the Corrales Siphon. Significant inundation areas include the following:

1. Extensive inundation along the left bank from Corrales Siphon to just downstream from the North Diversion Channel.

2. Left bank, approximately 4,000 feet upstream from the Central Avenue Bridge (approximately midway between Central Avenue and I-40 Bridges) to midway between Central Avenue and Bridge Street Bridges.

3. Extensively along the left and right banks from approximately 8,000 feet upstream from the Rio Bravo Bridge to just downstream from the Rio Bravo Bridge.

4. Extensive inundation along the left and right banks from the South Diversion Channel to the downstream end of the project reach.

Under Hydrology Scenario 3, approximately 1,036.3 of the 5,840 acres of available floodplain (about 17.75 percent) are inundated during the hydrograph. The extent, maximum depth and duration of inundation for this scenario are shown in the MEI Report in Technical Appendix F.

2.2.4.5 Existing Conditions: Hydrology Scenario 4 (100-year Snowmelt Hydrograph)

Based on the maximum computed water-surface elevations during the 100-year snowmelt hydrograph (Hydrology Scenario 4), overbank inundation occurs at similar locations to the 10,000 cfs hydrograph (**Figure 2.7**), but with less total area of inundation (Table 2.3). Under this scenario in which the peak discharge is about 7,750 cfs, approximately 657.2 of the 5,840 acres of available floodplain (about 11.25 percent) is inundated during the hydrograph. The majority of the overbank inundation occurs for approximately 14 to 16 days during the 3-month hydrograph.

2.2.5 SEDIMENT-CONTINUITY ANALYSIS

A baseline sediment-continuity analysis was performed to evaluate the potential for aggradation or degradation in response to both individual short-term hydrographs and longer-term flows (50-year project life) with the present channel configuration and reservoir operations. In general, the analysis was conducted by estimating the bed-material transport capacity of the supply reach and each subreach within the study area for each hydrology scenario and comparing the resulting capacity with the supply from the upstream river and tributaries within the reach. For this analysis, Hydrology Scenarios 2, 3 and 4 (mean annual runoff, 10,000-cfs, and 100-year snowmelt hydrographs, respectively) were used for the individual hydrographs, and the mean daily flow-duration curve from the Albuquerque gage for the post-Cochiti Dam period was used for the long-term analysis.

To facilitate the analysis, bed-material transport capacity rating curves were developed for each subreach using hydraulic output from the 500-foot grid FLO-2D model, representative bed-material gradations and the Yang (Sand) sediment-transport equation (Yang, 1973). In a previous study for the URGWOPS EIS, MEI (2004) evaluated a range of possible transport equations that were developed for conditions similar to those in the project reach, and determined that this equation produced results that were the most consistent with the available measured data at the Rio Grande gages downstream from Cochiti Dam among the available equations. The sediment-transport rating curves were then integrated over the individual hydrographs or the flow-duration curve to obtain a transport capacity volume for each hydrology scenario. In comparing the volumes, when the transport capacity of a particular subreach exceeds the supply, the channel will respond by either degrading (i.e., channel downcutting) or coarsening its bed material, and when the supply exceeds the capacity, the channel will respond by aggrading or fining its bed material. It should be noted, however, that significant amounts of downcutting or aggradation can also lead to lateral instability. The upstream supply reach used for this study extends from the upstream limit of the project reach to Arroyo de la Baranca (located approximately 2 miles downstream of Bernalillo), a distance of approximately 29,000 feet.

The representative bed-material gradations used in the analysis were taken from MEI (2004), with the gradation for URGWOPS Subreach 12a (Bernalillo to Rio Rancho Wastewater Treatment Plant) representing the supply reach and Subreach 12b (Rio Rancho to Isleta Diversion Dam) representing the primary study reach for this project (**Figure 2.11**). These gradations were developed using data collected by the BOR and USGS after 1990 and by MEI for various studies in 2002 and 2003. Observations by the BOR indicate that fine material that is not characteristic of the typical bed material that controls the form of the channel tends to accumulate as a veneer over the primary bed material during the non-runoff season but is removed during the runoff season. To avoid biasing the results to this finer material, the data sets were restricted to samples that were collected between May 1 and August 31 because this is the period of highest flows when the fine material is not likely present.

The bed-material gradations for the supply reach were based on a previous analysis of bed-material data collected at BOR Rangelines BB340 and BB345 in May 2001 (MEI, 2004). These data were used to develop a representative bed material gradation for Subreach 12a that is located between Bernalillo and Rio Rancho (**Figure 2.12**). The data set for the primary project reach consisted of 17 bed-material samples collected by the USGS at the Albuquerque gage between 1990 and 1996, and 16 samples collected by the BOR at Rangelines CA-1 to CA-13, A-1, A-4, A-6, and CR355, CR378 and CR443 between 1998 and 2001. The BOR data typically included several surface bed-material measurements along each range line. As a result, the samples collected at each range line were averaged to represent a single measurement location. The USGS samples also include several surface bed-material measurements collected along the cross section where their discharge measurements were collected. Similar to the BOR data, the samples collected along the cross section were averaged to represent a single measurement location. The project reach data set also included three bulk samples collected by MEI in July 2003 from exposed channel bars between Interstate 40 and Montano Boulevard that are representative of the surface bed material in this reach (MEI, 2003).

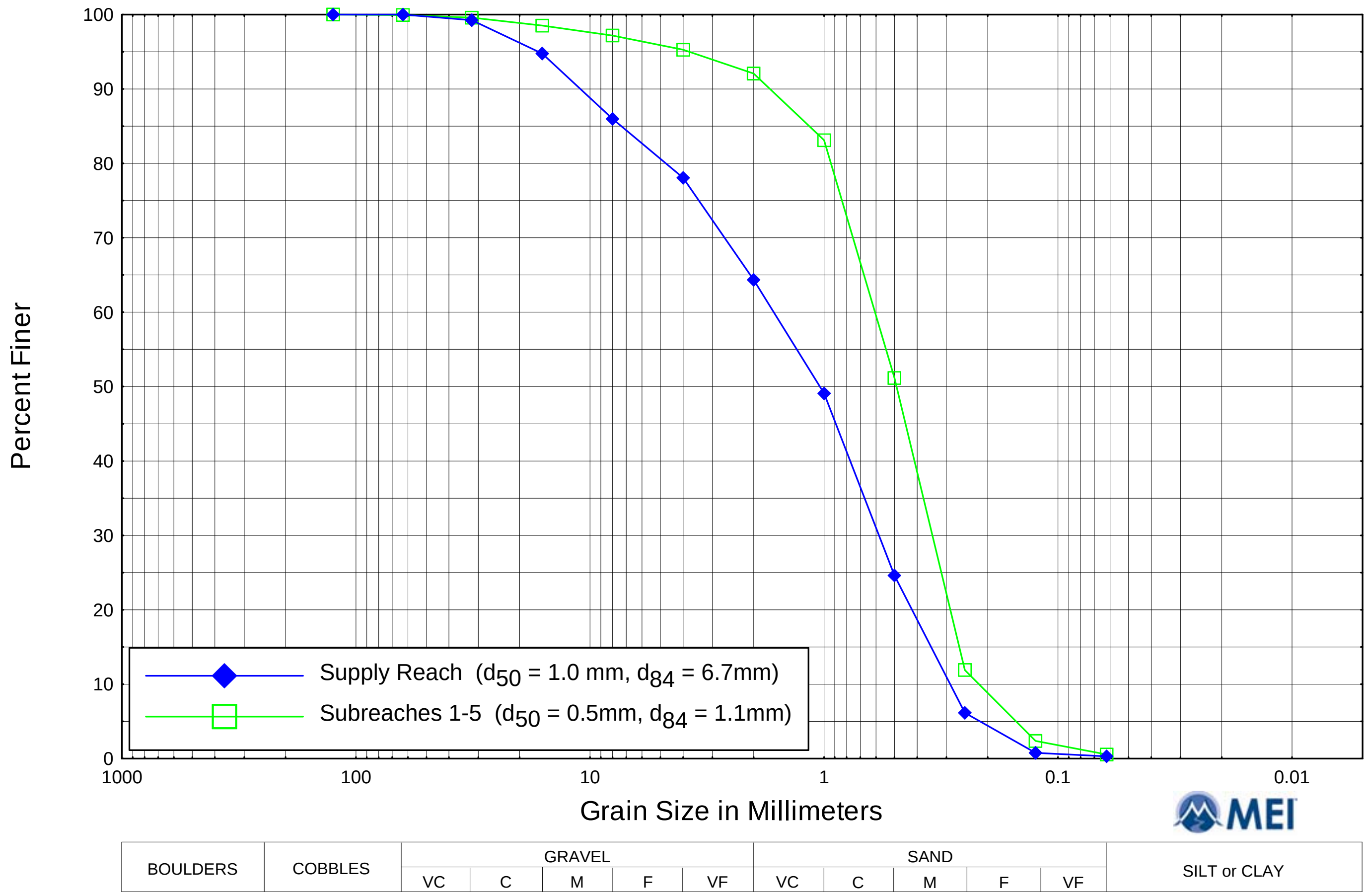


Figure 2.11 Representative bed-material gradation curve for the project reach that was used in the sediment-continuity analysis.

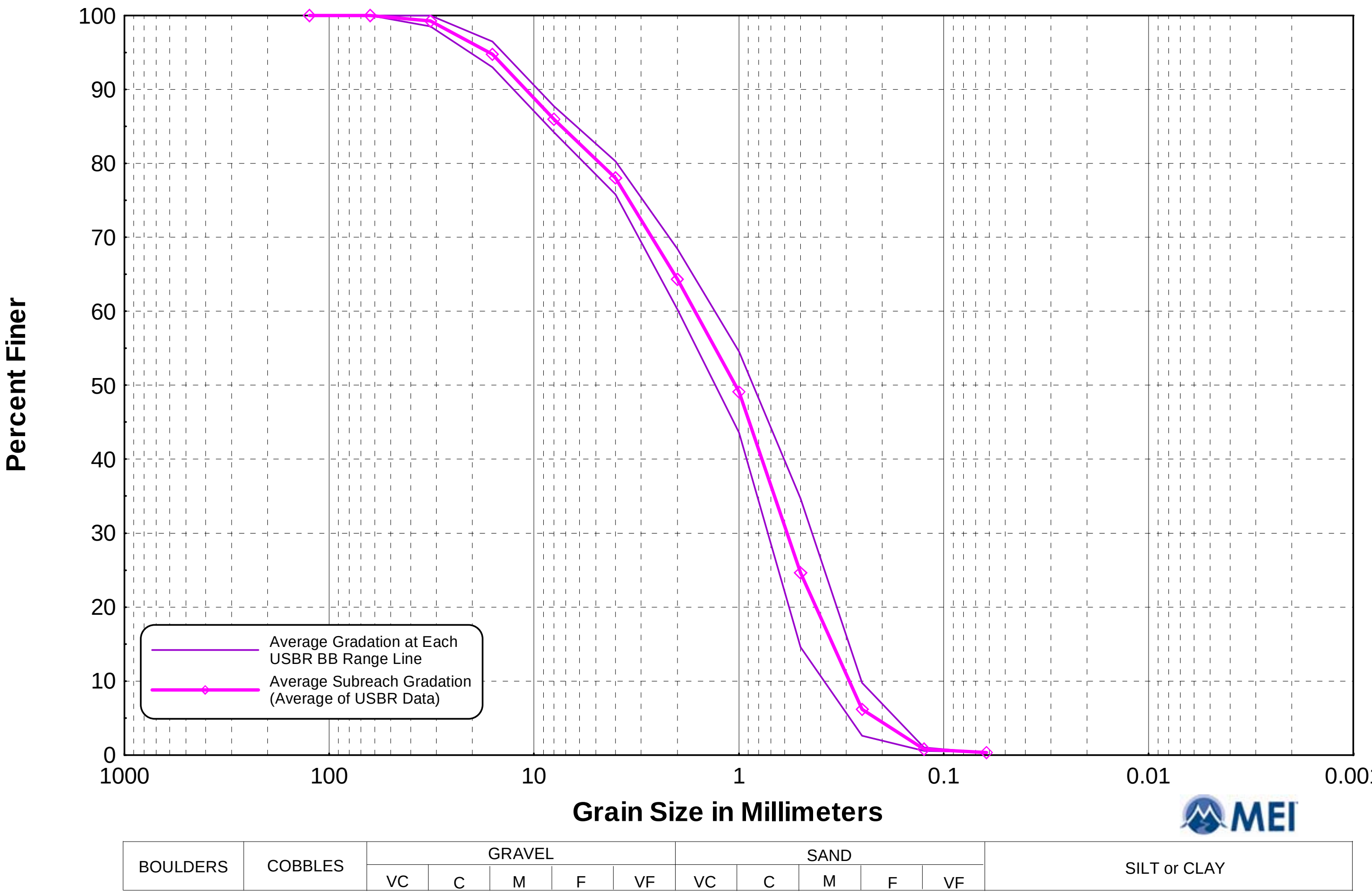


Figure 2.12 Representative bed-material gradation curve for the supply reach that was used in the sediment-continuity analysis.

The supply reach gradation has a median size of about 1 mm (coarse sand), contains material up to about 128 mm, and about 42 percent of the material is in the gravel- and cobble-size range (Figure 6.1). The gradation for the primary project reach has a median size of 0.5 mm (medium and coarse sand), contains material up to about 32 mm, and about 92 percent of the material is sand.

To validate the general approach for estimating the transport capacity rating curves, a bed-material rating curve was developed using hydraulic results from the FLO-2D model for the main channel at Albuquerque gage and compared to measured values at the gage (**Figure 2.13**). The resulting rating curve is consistent with the measured data, indicating that the approach is appropriate. Rating curves based on the reach-averaged hydraulics for each of the subreaches are shown in **Figure 2.14**.

2.2.5.1 Tributary Bed-material Contributions

Three tributaries (Calabacillas Arroyo, North Diversion Channel, and South Diversion Channel) were identified along the study reach that have the capability to deliver significant quantities of sediment to the Rio Grande (**Table 2.5**). Sediment loads from the North Diversion Channel (NDC) were obtained from a study performed by the Corps Waterways Experiment Station (WES) to evaluate sedimentation conditions in the NDC (Copeland, 1995). The basic sediment supply information used by Copeland (1995) was developed from a study of the arroyos draining to the NDC that was performed by Mussetter and Harvey (1993). Due to the lack of available data for Calabacillas Arroyo and the South Diversion Channel (SDC), annual bed-material loads were estimated by assuming a unit bed-material supply of 0.1 ac-ft/mi^2, which is generally consistent with the range of unit yields from the tributaries for which information is available. Calabacillas Arroyo, the NDC and the SDC are ephemeral channels that flow in response to rainfall events. Historically, significant floods from Calabacillas Arroyo have formed a large fan at the confluence with the Rio Grande that have fully or partially blocked the river at various times. Large magnitude events in the arroyo, such as the 1941 and 1988 floods, caused the Calabacillas Arroyo fan to prograde into the Rio Grande. Development of the watershed, channelization of Calabacillas Arroyo and construction of Swinburne Dam (completed in 1991) has likely reduced the sediment load to the Rio Grande.

2.2.5.2 Sediment-continuity Analysis Results

Integration of the transport capacity rating curves over the mean annual hydrograph results in a transported volume through the study reach of about 100 ac-ft of sediment (Figure 2.14). The transported volume increases to about 450 ac-ft and 630 ac-ft for the 10,000-cfs and 100-year snowmelt hydrographs, respectively (**Figures 2.16 and 2.17**). Based on integration of the annual flow-duration curve, the long-term, average annual bed-material load through the study reach is about 240 ac-ft (**Figure 2.16**). (This value is higher than obtained for the mean annual hydrograph because the flow-duration curve includes flows that significantly exceed the mean annual flood peak.)

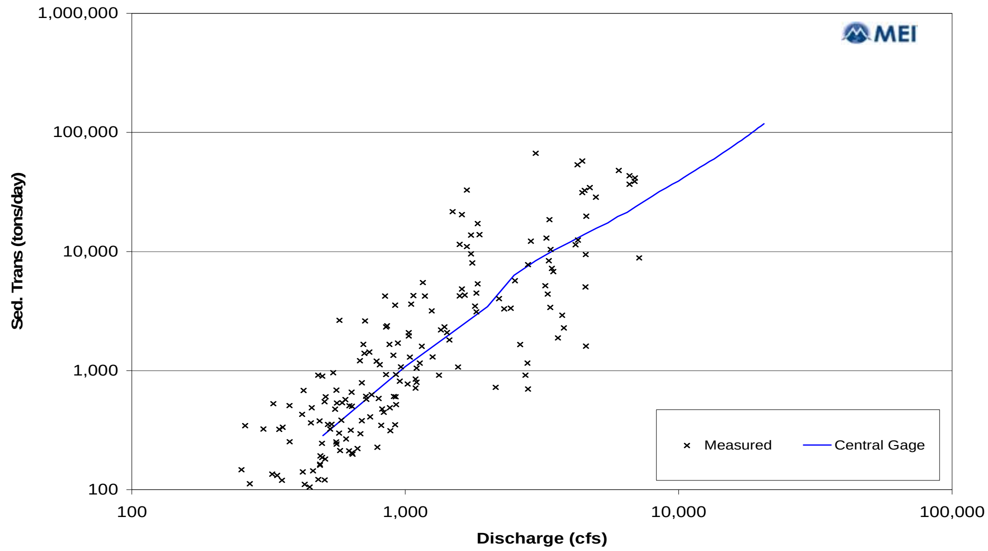


Figure 2.13 - Bed-material rating curve at the Albuquerque gage developed using the Yang (Sand, 1973) relationship and measured bed-material loads at the Albuquerque gage.

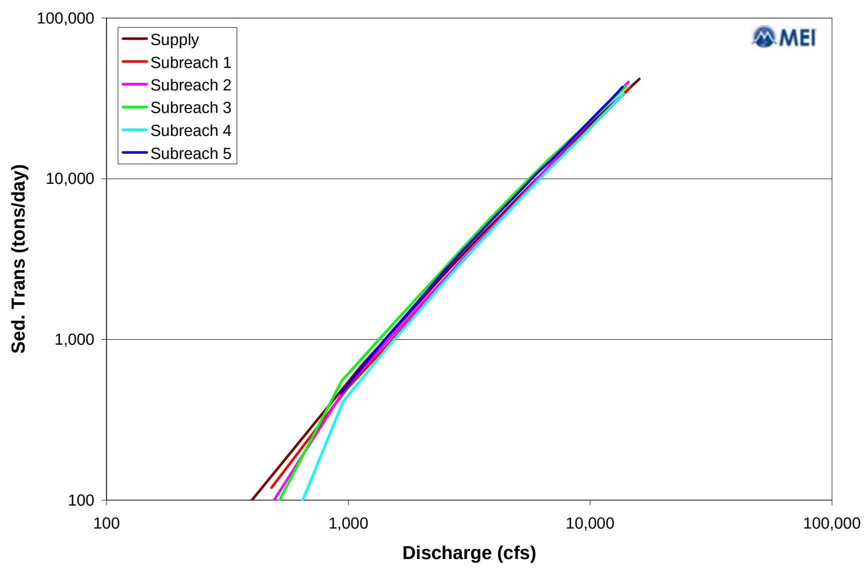


Figure 2.14 Bed-material rating curves for each of the subreaches in the sediment continuity analysis.

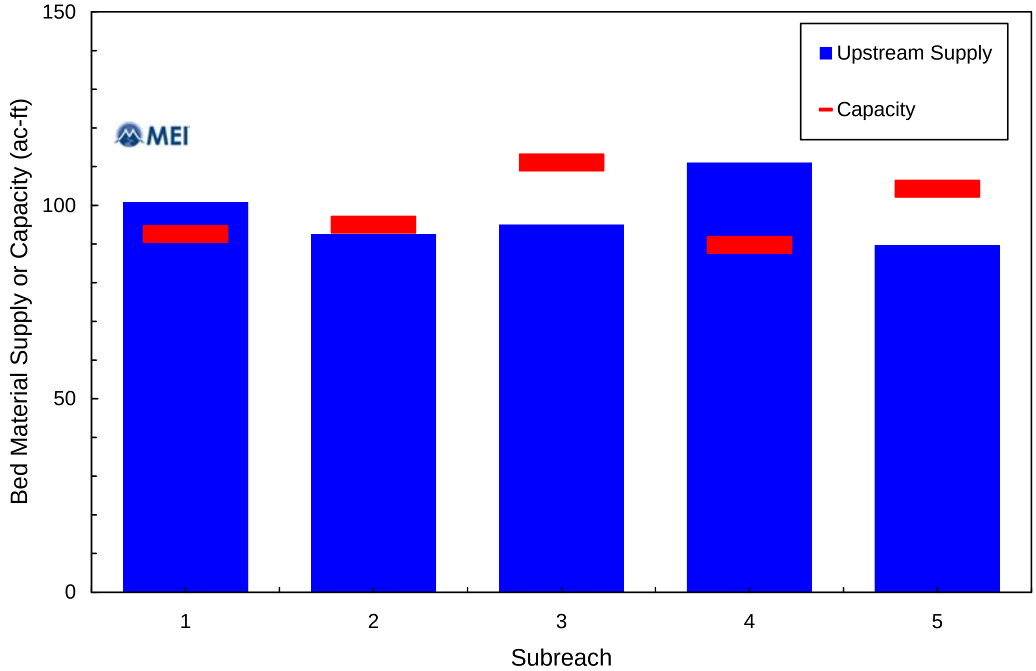


Figure 2.15 Comparison of average annual supply and bed-material transport capacity for each subreach.

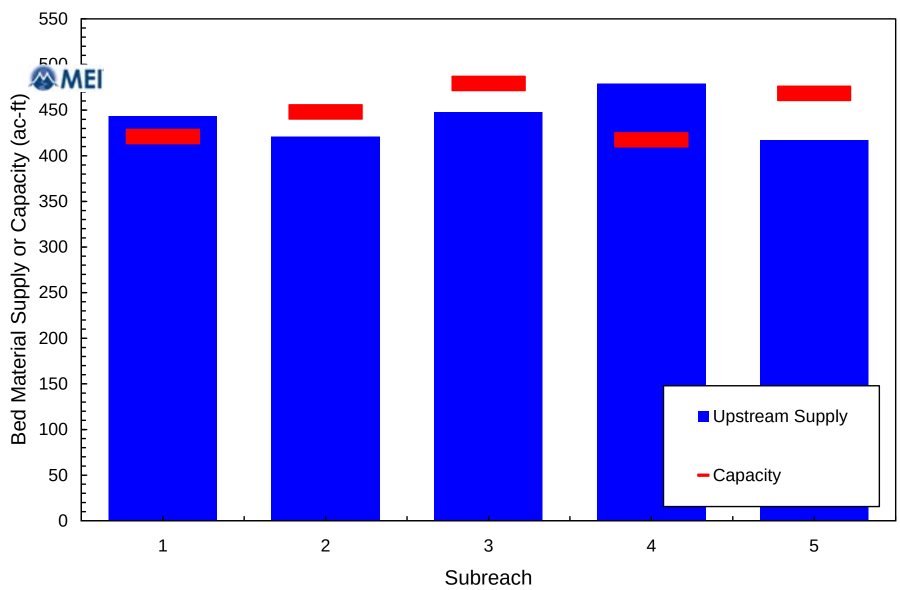


Figure 2.16 Comparison of supply and bed-material transport capacity for each subreach for the 10,000-cfs hydrograph.

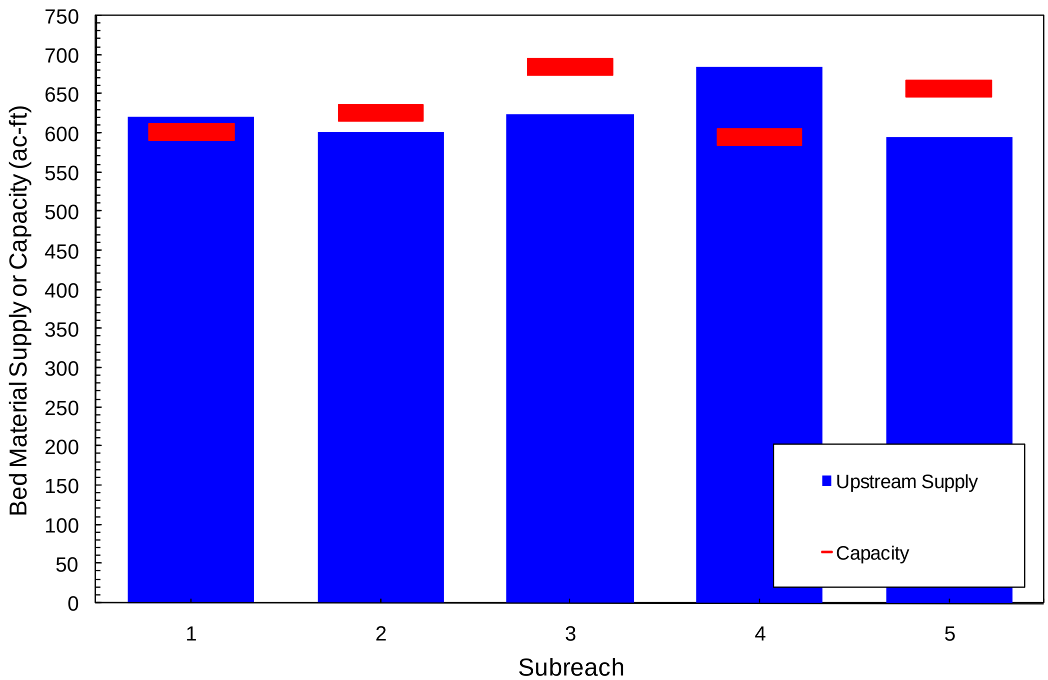


Figure 2.17 Comparison of supply and bed-material transport capacity for each subreach for the 100-Year snowmelt hydrograph.

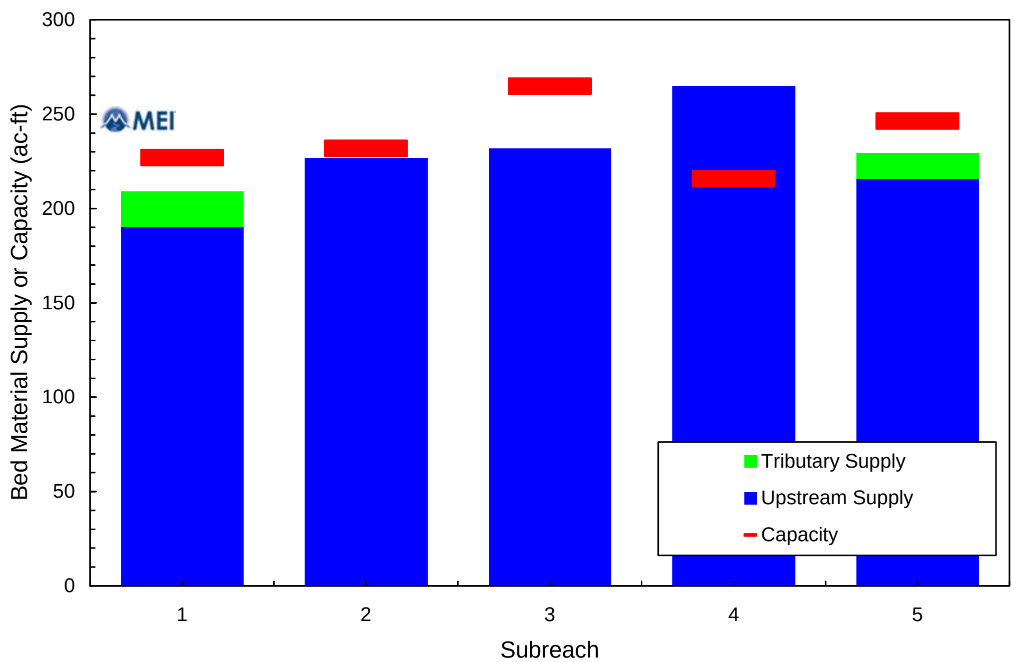


Figure 2.18 Comparison of supply and bed-material transport capacity for each subreach for the flow-duration curve.

Table 2.5 Summary of tributaries included in the sediment-continuity analysis, and the average annual bed-material contribution from each of the tributaries (modified from MEI (2004).				
Tributary Name	Drainage Area (mi^2)	Average Annual Sediment Volume (ac-ft)	Unit Volume (ac/mi^2)	Source
Calabacillas Arroyo	100.8	10.1	0.10	Assumed 0.1 ac-ft/mi^2
North Diversion Channel	102	8.3	0.08	Copeland (1995)
South Diversion Channel	133	13.3	0.10	Assumed 0.1 ac-ft/mi^2

The results shown in **Figures 2.15** through **2.18** indicate that the bed-material transport capacity is relatively consistent from subreach to subreach, although there is a slight net degradational tendency, in the absence of tributary sediment inputs, for the overall study reach for all three of the individual storm hydrographs that were analyzed. For the average annual hydrograph, the transport capacity at the downstream end of the reach is about 104 ac-ft compared to the upstream supply of about 101 ac-ft (Figure 2.15). For the 10,000-cfs hydrograph, the transport capacity at the downstream end is about 468 ac-ft capacity versus 444 ac-ft of supply (**Figure 2.16**), and the 100-year snowmelt hydrograph, the downstream capacity is about 657 ac-ft capacity at the downstream end versus 622 ac-ft of supply (Figure 2.17). (Note that tributary inputs were not considered for the mean annual, 10,000-cfs and 100-year snowmelt hydrographs because storms in the tributaries will most likely occur during the monsoon season in late-summer and early-fall, while the large runoff hydrographs in the river typically occur during the spring snowmelt runoff period.) On a long-term average annual basis, the transport capacity at the downstream end of the reach is about 246 ac-ft compared to the supply of 209 ac-ft (**Figure 2.18**).

In spite of the overall degradational tendency, Subreach 4 tends to be aggradational for all of the hydrology scenarios. Over time, the upstream Subreaches 1, 2 and 3 will probably respond to the deficit by coarsening of the bed material as these subreaches approach a balance between the supply and capacity. The coarsening will decrease the supply to Subreach 4 which will bring this reach into closer balance between the supply and capacity, reducing the aggradation potential.

The approximate change in bed elevation (i.e., aggradation/degradation potential) associated with these differences in volume were estimated by dividing the difference between the bed material supply and capacity of the subreach by the surface area of the channel, based on the product of the subreach length and channel topwidth (**Table 2.6**). In evaluating this information, it is important to note that the actual changes will not occur uniformly throughout the reach or across the channel at any given location, nor will they continue progressively for a long period of time because the bed material, channel geometry and gradient will adjust to compensate for imbalances between the sediment supply and transport capacity. In spite of this limitation, the analysis provides a reasonable basis for comparing results from the sediment-continuity analysis.

Table 2.6 Summary of subreaches defined for the channel-stability analyses.			
Subreach	Subreach Length (ft)	Main Channel Topwidth (ft)[1]	Limits
1	10,760	710	Southern boundary of the Pueblo of Sandia to Alameda Bridge
2	22,190	650	Alameda Blvd. Bridge to Montano Blvd. Bridge
3	23,430	500	Montano Blvd. Bridge to Central Avenue Bridge
4	32,190	545	Central Avenue Bridge to the South Diversion Channel
5	25,640	550	South Diversion Channel to the northern boundary of the Pueblo of Isleta

[1]at the active channel-full flow of 6,000 cfs

For the average annual hydrograph, Subreaches 1 and 4 are net aggradational (average of 0.04 and 0.05 feet, respectively) with no tributary inputs (**Figure 2.19**). Subreach 2 is approximately in balance with the upstream supply (-0.01 feet) and Subreaches 3 and 5 are net degradational (average depth of -0.06 and -0.04 feet, respectively). For the 10,000-cfs hydrograph, Subreaches 1 and 4 are net aggradational (both have an average of 0.13 feet) with no tributary inputs (**Figure 2.20**). Subreaches 2, 3 and 5 are net degradational (average of -0.07, -0.11, and -0.15 feet, respectively) in the absence of tributary inputs. For the 100-year snowmelt hydrograph, Subreaches 1 and 4 are net aggradational (average of 0.12 and 0.19 feet, respectively) with no tributary inputs (**Figure 2.21**). Subreaches 2, 3 and 5 are net degradational (average of -0.07, -0.21, and -0.18 feet, respectively) in the absence of tributary inputs. On a long-term, average annual basis, Subreaches 1, 3 and 5 are net degradational (average of -0.11, -0.11, and -0.05 feet, respectively). Subreach 2 is approximately in balance with the upstream supply (-0.01 feet, on average) and Subreach 4 is net aggradational (average of about 0.13 feet) with tributary inputs (**Figure 2.22**).

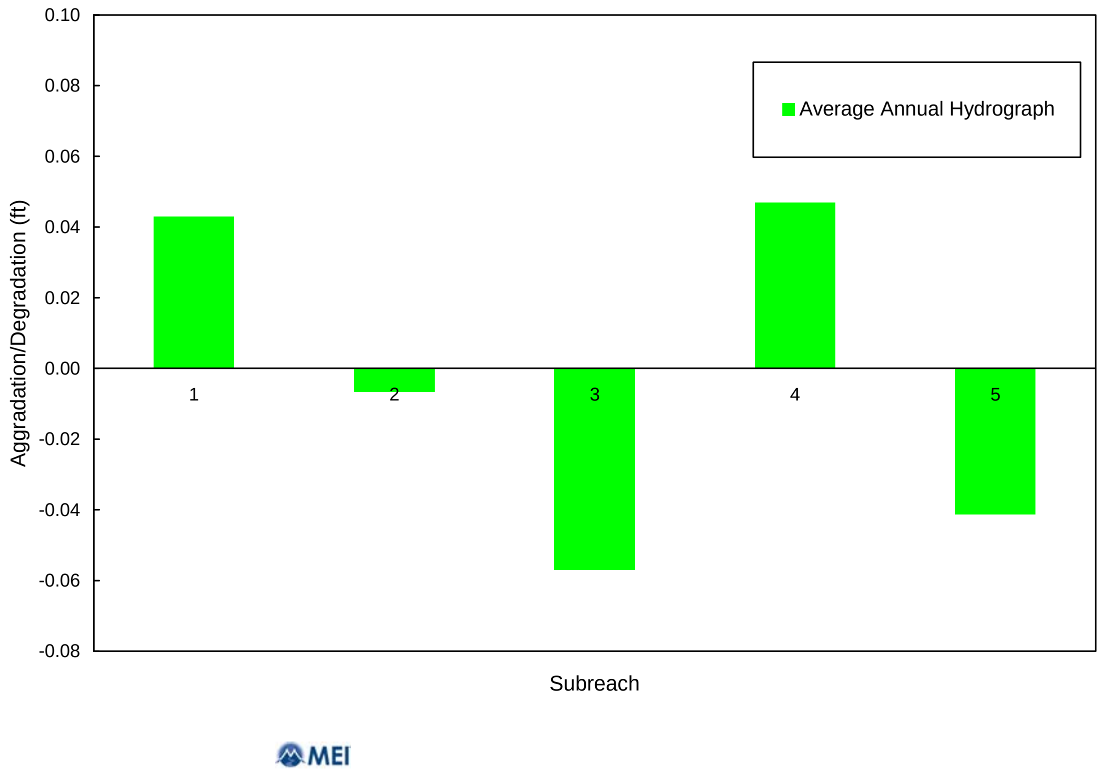


Figure 2.19 Computed average annual aggradation/degradation depths for each subreach.

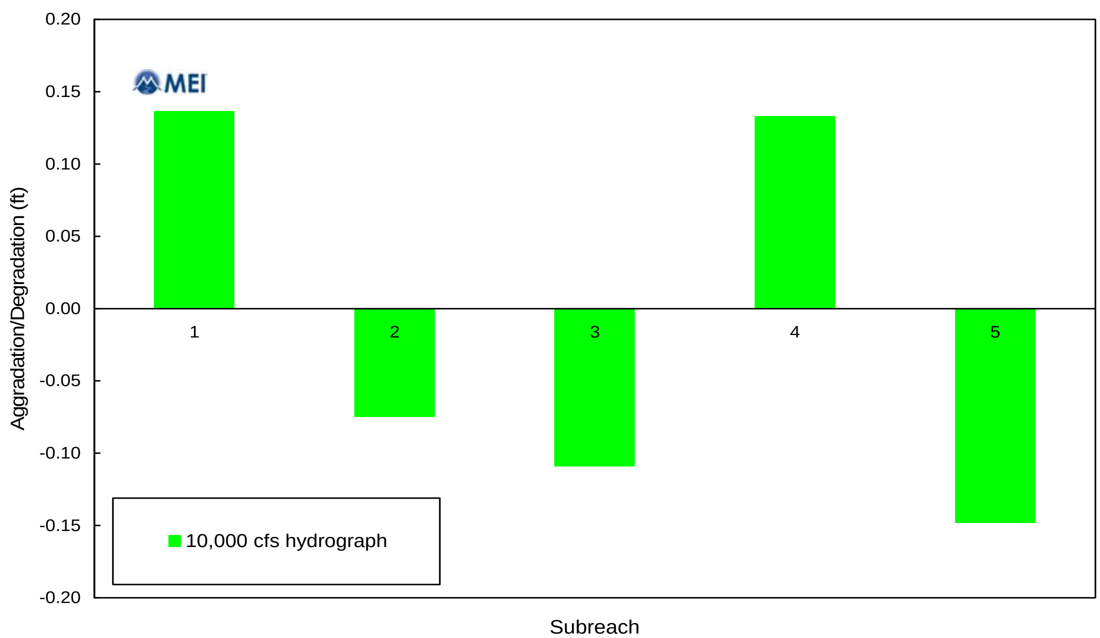


Figure 2.20 Computed aggradation/degradation depths for each subreach for the 10,000-cfs hydrograph.

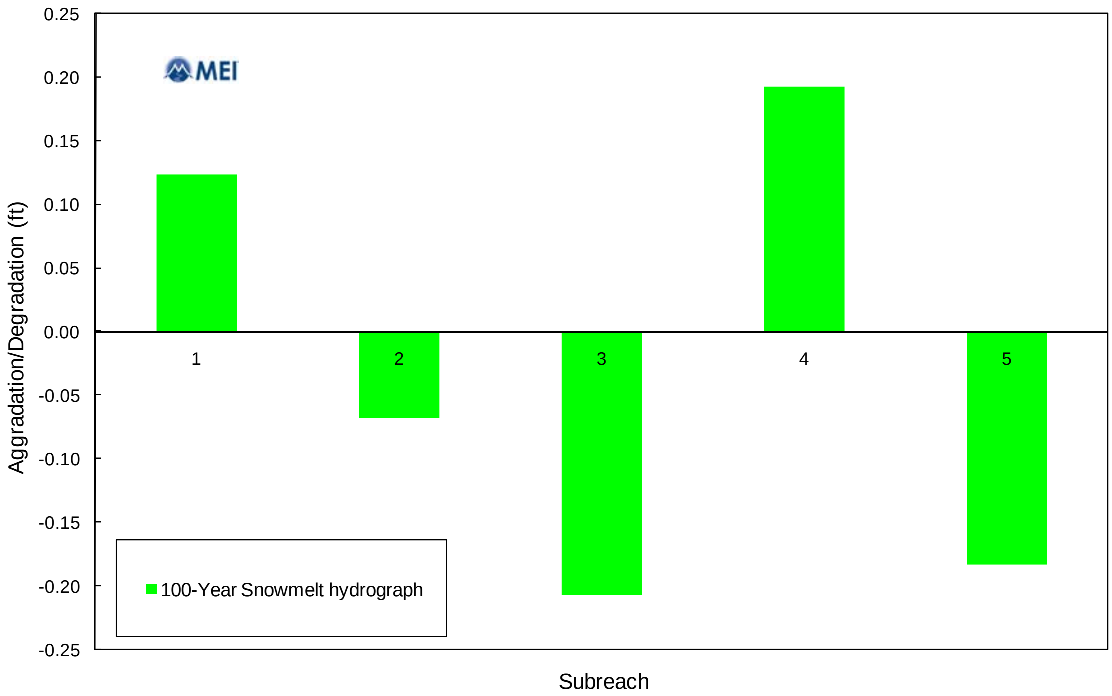


Figure 2.21 Computed aggradation/degradation depths for each subreach for the 100-year snowmelt hydrograph.

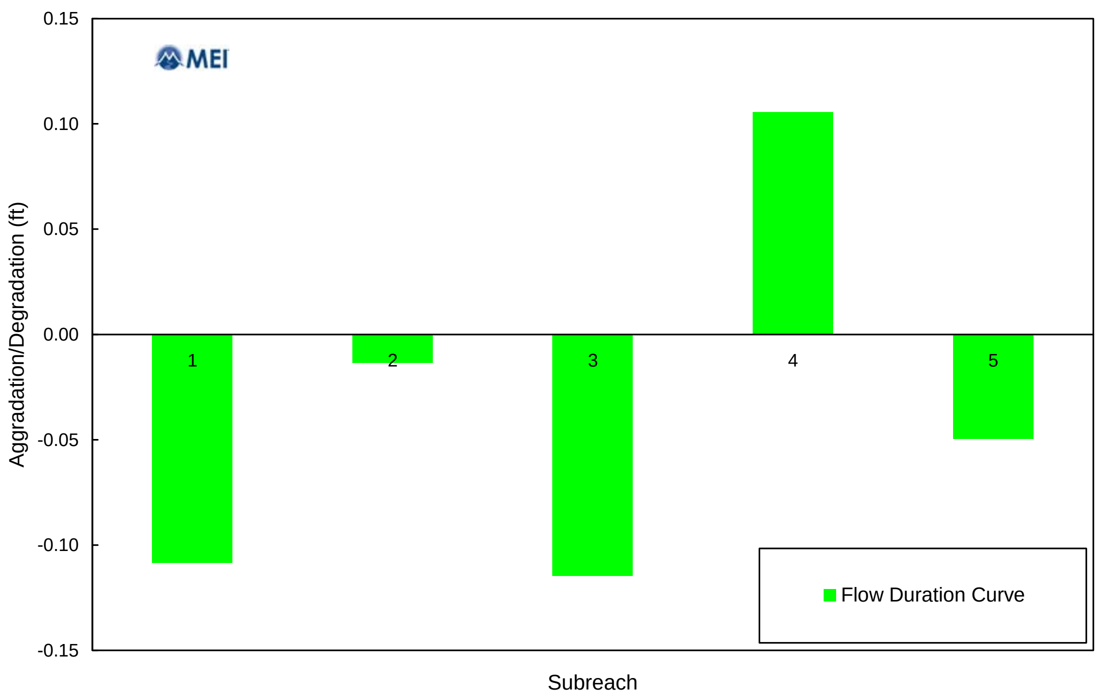


Figure 2.22 Computed aggradation/degradation depths for each subreach for the flow-duration curve

2.2.6 Channel Maintenance

There are four main categories of channel maintenance activities that are included in the USBOR program. These include bank stabilization, river training, sediment removal, and vegetation control. Bank stabilization is accomplished through a variety of techniques including traditional uses of rock to provide bank protection. However, the installation of Kellner jetty jacks (named after their designer) has been the most commonly employed method in the Middle Rio Grande. A schematic of their installation is shown in **Figure 2.23**.

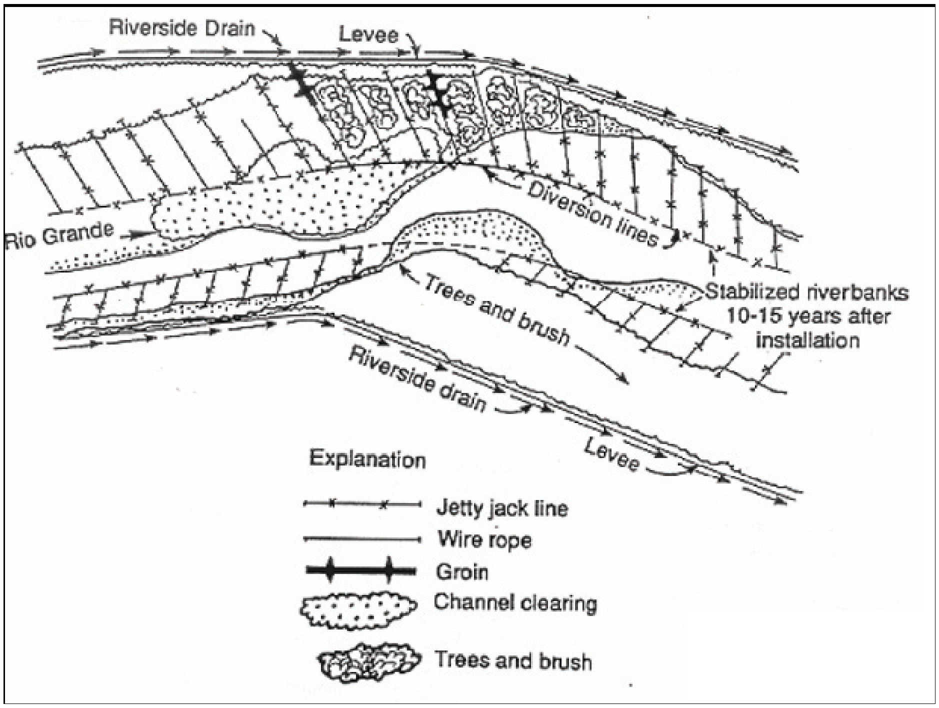


Figure 2.23 Schematic of Channel Alterations

As shown in the figure, jetty jacks were placed along the river's edge and along the levees. These lines of cabled jetty jacks were connected to each other by strings of jetty jacks that ran diagonally between them. Jetty jacks are designed to reduce water velocities, encouraging sediment to drop out. When enough sediment has been deposited in an area, riparian vegetation becomes established and ultimately stabilizes the banks. There are places within the Study Area where more than six feet of sediment has been deposited and has essentially buried the jetty jacks. **Figure 2.24** shows the current location of jetty jacks within the Study Area. While they have been effective in achieving their original goal, many of the jacks may no longer be needed. Vegetation has been established that may now provide the bank stabilization originally intended. In some cases non-functional jacks are now more of a problem than a solution as some people consider them to be obstacles. Additional information on the benefits and concerns of jetty jacks is presented in later sections of this report.

Based on earlier studies and a preliminary determination by a special task force comprised of engineers from Corps, MRGCD and USBOR, non-functional jetty jacks are those that no longer provide bank stabilization, defined as armoring, for levees or bridge abutments. For the Study Area, that includes primarily all jetty jacks located where there is mature vegetation protecting a bank line, protecting bridge abutments, or found in areas where the bank is less than 100 feet in width. Many of the bank line jacks would be difficult to remove due to their being deeply embedded in the riverbank

River training activities include a broad group of modifications intended to influence flow alignment and manage overbank flows. Examples are groins and training dikes (in-channel embankments constructed to protect riverbanks) and pilot channels to establish new river courses. An example of a pilot channel is the Low Flow Conveyance Channel upstream of Elephant Butte Reservoir. While these techniques have been used in the Middle Rio Grande, they are less prevalent within the current Study Area.

Figure 2.24 Jetty Jacks in the Study Area

Sediment removal from the river channel by mechanical means is another method occasionally employed by the USBOR. Channel capacity is maintained by removing sediment deltas deposited from arroyos, as well as islands and sand or gravel bars within the channel.

Vegetation control is the final category of channel modifications performed by the USBOR. Historically this included large-scale removal of vegetation on the overbanks to increase the floodway capacity of the system. Currently this is mainly limited to the periodic mowing of new vegetation that becomes established on the river bars.

2.3 Water Quantity

It is estimated that the average annual water loss due to evapotranspiration (ET) in the Middle Rio Grande riparian corridor accounts for 20-50 percent of that reach's total water depletion (Dahm et al. 2002). Bosque ET appears to be higher in dense stands of salt cedar and in mature stands of cottonwood containing an extensive understory of salt cedar and Russian olive than it is in less dense salt cedar stands and mature cottonwood stands with few understory trees (Dahm et al. 2002). The project area contains large areas that are predominately tall trees with a relatively dense understory of saplings and shrubs and open stands of mid-sized tress with widely scattered shrubs and sparse herbaceous growth, although most of the understory is composed of salt cedar. It has been estimated that ET in the most dense portions of the Study Area equals approximately 562.6 acre-feet annually. There are currently no water restoration features within the project area. A net depletions analysis is presented in Section 6.3, **Table 6.1**.

2.4 Water Quality

The Rio Grande water quality in the Study Area is characterized by relatively high turbidity and slight to moderate alkalinity (Pierce 1989). Average total suspended and total dissolved solids concentrations in the Rio Grande in the Study Area are about 7,000 mg/l and 250 mg/l, respectively (Crawford et al. 1993). Designated uses for the Rio Grande in the Study Area are irrigation, limited warm water fishery, livestock watering, wildlife habitat, and secondary contact (20.6.4 New Mexico Administrative Code §105). If applicable, general criteria set out in Subsections A, B, C, D, E, G, H and J of 20.6.4.13 NMAC, and the provision set out in Subsection E of 20.6.4.14 NMAC, would be adhered to. All Federal, State, and Local regulations would apply. Relevant surface water quality standards for this reach include a maximum average monthly total dissolved solids concentration of 1,500 mg/l when flows are greater than 100 cfs.

Figure 2.25 Storm Water Outfall near Bridge Boulevard, East Side of the River

Water quality in the Rio Grande through the Study Area is impacted by fecal coliform contamination, municipal point sources, urban runoff, and storm sewers (NMED Surface Water Quality Bureau 2002). There are three major storm sewer outfalls to the Rio Grande in the Study Area. Two of these outfalls are located on the east side of the river between the Bridge Boulevard and Central Avenue crossings **Figure 2.25**. The third outfall is located near the old Atrisco Diversion on the west side of the river between the Central Avenue and I-40 crossings. Contaminants introduced to the Rio Grande from these outfalls include solid waste, oils, pesticide and herbicide residues, phosphorous, nitrogen, and fecal coliform (Tague and Drypolcher 1979).

2.5 Air Quality

Air quality is regulated by National Ambient Air Quality Standards established by the Federal Clean Air Act (CAA), as amended in 1990. The CAA and its associated regulations were developed to protect the public from exposure to dangerous levels of six criteria air pollutants: carbon monoxide (CO), ozone, airborne particulates, sulfur dioxide, nitrogen dioxide, and lead. The City of Albuquerque's Environmental Health Department is responsible for regulating all sources of ambient air pollution in Bernalillo County.

Bernalillo County is currently designated as a "maintenance" area for carbon monoxide (CO) and an "attainment" area for all other pollutants regulated by National Ambient Air Quality Standards (NAAQS). Prior to 1992, the standards for CO were exceeded on numerous occasions in the Albuquerque metropolitan area. The NAAQS for CO include a maximum 1-hour average concentration of 35 parts per million (ppm) and a maximum 8-hour concentration of 9 ppm. Previous violations of the CO standards were generally attributed to mobile sources (for example, vehicle exhaust) and residential wood burning. However, as a direct consequence of several national and local air quality improvement strategies, no violations of the CO standards have occurred in the County since 1991 (D. Warren, personal communication, 11 April 2003).
Another potential pollutant of concern in Bernalillo County is particulate matter, which includes particles smaller than 10 microns (PM_{10}). According to the City's Environmental Health Department, the County has historically recorded exceeding the Federal 24-hour standard for PM_{10}, and in 2002, the County came close to exceeding the annual threshold for PM_{10}. PM_{10} issues in the area are generally attributed to windblown dust arising from lands disturbed by human activities (D. Warren, personal communication, 11 April 2003). To address the potential concerns associated with PM_{10}, the City and County have adopted a fugitive dust control ordinance which requires construction activities disturbing more than three-quarters of an acre to obtain a fugitive dust control permit and prepare a dust control plan as part of the project.

Bernalillo County is in attainment for particulate matter smaller than 2.5 microns ($PM_{2.5}$), sulfur dioxide, nitrogen oxide, and lead. Levels of sulfur dioxide and lead are so low that they are not monitored by the County (D. Warren, personal communication, 11 April 2003).

2.6 Noise

Albuquerque's noise control ordinance was placed into effect in June 1975. The Environmental Health Department's Consumer Protection Division personnel are responsible for enforcing the ordinance. Noise control enforcement may involve many sources of excessive noise: radios, stereos, television, live bands, machinery, equipment fans, air conditioners, construction, vehicle repairs, motor vehicles, and general noise. The ordinance stipulates a property-line value in which the noise level emitted must not exceed 50 decibels (dB) or 10 decibels above the ambient level; whichever is greater (Mitzelfelt, 1996). For example, if you are playing a stereo, the sound level traveling from the stereo to the neighboring property lines cannot be more than 10 decibels higher than the general noise level existing before the stereo was turned on. Noise level meters are used to measure the sound level as it is crossing the property line. The meters are similar to radar meters the police use for speed detection; however, instead of detecting an object in motion, it detects air pressure (sound waves) in motion and produces a numbered level called decibels.

The Study Area currently receives noise from a variety of sources both within and outside of the bosque. Current sources of noise within the bosque are attributable to 1) machinery and vehicle operation, 2) humans, and 3) wildlife and domestic animals. The first group, machinery, creates the loudest sounds. Noise from machinery is often very loud and continuous over long periods of time in certain areas. In other places, it is relatively low-level and intermittent or does not occur at all. Noise sources emanating from outside the bosque but that can be heard in the bosque include the three sources previously mentioned as well as sounds of traffic on nearby bridges and roads.

Generally, there is a fair amount of noise that is generated by people and machinery within and outside the bosque on a daily basis, particularly in warmer months when there is more activity in the area. Noise from outside the bosque is somewhat buffered within the bosque in areas of dense vegetation and in areas furthest from roads and bridges.

2.7 Ecological Setting and Resources

2.7.1 Plant Communities

A mosaic of vegetation patches can be inferred as the historic, naturally functioning condition of riparian vegetation in the Study Area, based on a conceptual model of riparian patch dynamics developed by Pittenger (2003), Technical Appendix A as well as the Bosque Landscape Alteration Strategy (Najmi et al., 2005). The limited amount of historical information available on riparian vegetation in the Study Area also supports this inference. In a naturally functioning system, fluvial-geomorphic processes drive creation of bare, open sites available for establishment of native riparian and wetland vegetation. Changes in structure of vegetation patches that are spatially and temporally removed from the disturbances of channel dynamics are driven by biotic succession. Soil moisture regime (soil saturation, hydroperiod, depth to water table) in these patches has a major influence on successional development of riparian and wetland plant communities (Pittenger 2003 **Figure 2.26A**).

2.7.1.a Historical Perspective

Large wetlands and an extensive cottonwood gallery forest occupied the floodplain of the Rio Grande in the Study Area prior to major modifications of the ecosystem by man. Large cottonwood gallery forests on the east side of the Rio Grande from Tomé northward into Albuquerque were described in the mid-1700s (Scurlock 1998). In the 1600s the Bosque Grande de San Francisco Xavier, an extensive cottonwood gallery forest, occupied the east side of the Rio Grande from Alameda Pueblo downstream to the vicinity of present-day Barelas, where the forest gave way to a complex of wetlands known as the Esteros de Mejia (Scurlock 1998). The wetlands consisted of herbaceous marshes (cienegas), “swamps” or sloughs (esteros), and open-water ponds (charcos). The Bosque Grande de San Francisco Xavier was a prominent landscape feature at least into the early 1700s (Scurlock 1998). Scurlock noted that the wetlands and bosque “were sustained by a high water table and periodic flooding of the Rio Grande.” Flooding deposited fine-grained sediments “rich in nutrients” on the floodplain (Scurlock 1998).

Historic records also imply that the Rio Grande in the Study Area had a slightly meandering, single-thread channel morphology. The occurrence of large sloughs or oxbows, recorded in 1630 (Scurlock 1998), is evidence of meander cutoff, which is a characteristic of meandering stream channels. Well-vegetated, defined riverbanks, noted in 1782 (Scurlock 1998), are more consistent with a meandering channel morphology as

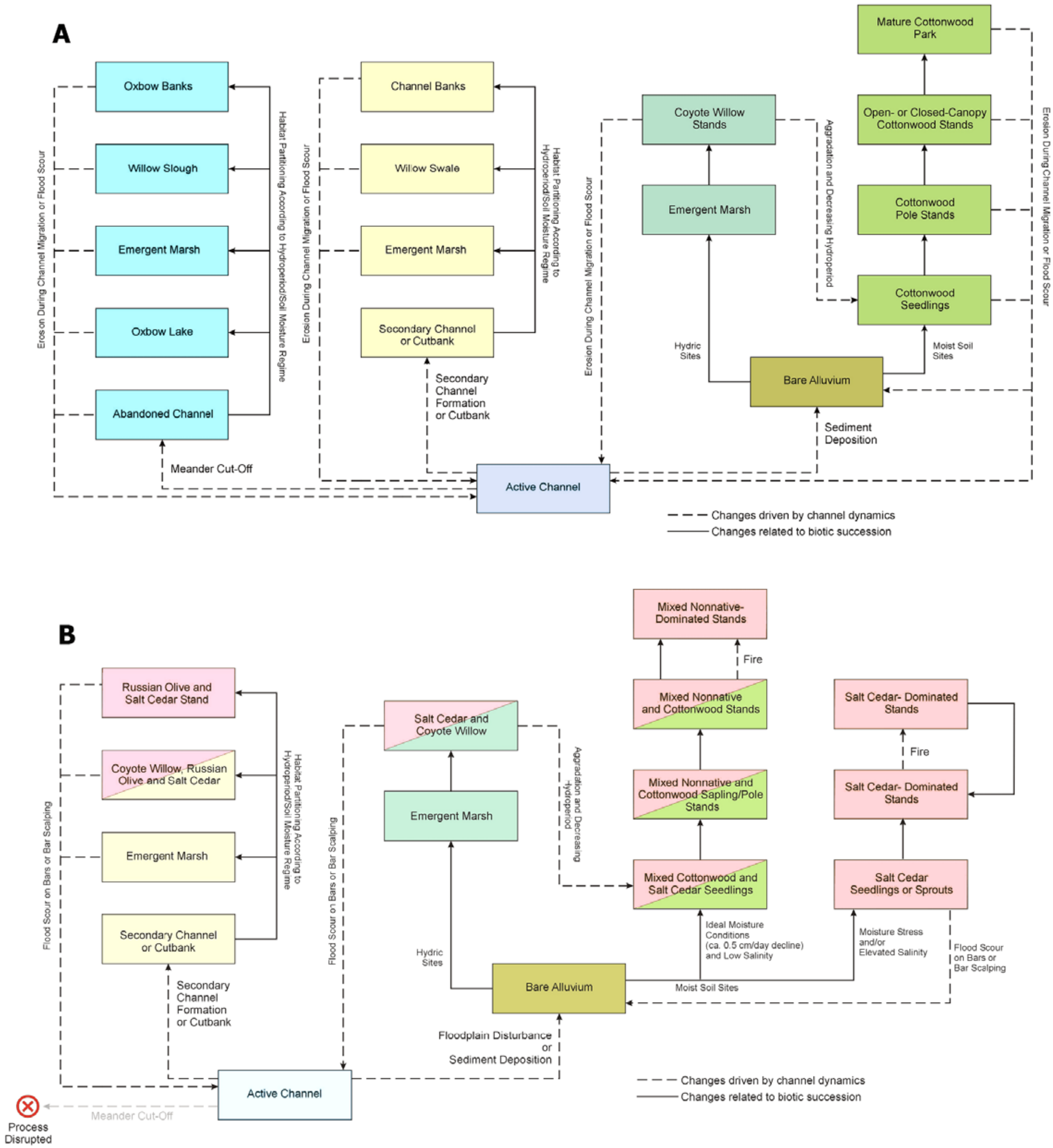


Figure 2.26 Comparison of Conceptual Models or Riparian Vegetation Dynamics in a Naturally Functioning Bosque Ecosystem (A) and the Current, Altered Bosque Ecosystem (B)

opposed to braided channels, which typically have highly erodible, shifting banks (Rosgen 1996). High width depth ratio, high sediment supply, and dune-antidune bed form are characteristic of meandering channels in fine-grained alluvium (Rosgen 1996).

Prior to regulation, the Rio Grande's flow regime was controlled by regional climate, basin geology, and floodplain geomorphology. The combined influence of these features was especially evident in the early growing season, when melting winter snows in the basin's upper watersheds produced a swollen river that often overflowed its banks. Those floods coincided with the release of wind blown cottonwood and willow seeds. They also prepared scoured banks for eventual seedling germination, and brought on avulsion events leading to new channel formation. This, in turn, left trees on abandoned banks lacking significant hydrologic connectivity with the river (Crawford et al. 1994, 1996). Depending on the distance and elevation change between the new and old channels, average water table depths at the abandoned banks would at times have been well below their previous levels. Trees on those banks would then have been at risk, as water table depths exceeding 3 meters result in cottonwood and willow water stress and eventual canopy dieback (Horton et al. 2001). Also impacted would have been seedling recruitment and nutrient uptake when soils beneath and around abandoned stands remained dry during the growing season.

Because of the apparent climatic uncertainty of the Holocene in what is now the U.S. Southwest (Graf 1994, Pearce 2003), it is speculated that the above scenario would have characterized a floodplain in which cottonwood and willow stands differed markedly in size, configuration, age, and health (Crawford and Grogan 2003). It is also assumed that open spaces varying in size in the floodplain would have supported dry land grasses and shrubs as they do now, for example, in power line clearings. In other words, the riparian landscape on the whole would have been structurally complex, with an extensive diversity of habitats and species (Crawford and Grogan 2003).

2.7.1.b Existing Plant Communities

Human induced changes in fluvial geomorphic processes that influence vegetation dynamics in the bosque were initiated at least as early as the late 1700s. These processes were progressively altered from the natural condition through the 1800s and into the mid-1900s, when imbalances between sediment supply and discharge and removal of riparian vegetation apparently created very unstable dynamics in the riverine and riparian ecosystems. Channelization, levee construction, Kellner jetty jack installation, sediment retention in reservoirs, and flow regulation reversed the processes of aggradation and channel widening. These river management measures also created a fixed channel plan form and a narrower floodplain that was less frequently inundated or disconnected entirely from the river. The result has been disruption or termination of major processes depicted in the conceptual model of dynamics in a naturally functioning bosque ecosystem (Pittenger 2003, and references cited therein; see Technical Appendix).

A major change in vegetation dynamics in the bosque ecosystem has been loss of meander cut-off, meander migration, and flood scour processes, which were a driving force in the dynamics of the naturally functioning system. These processes removed existing vegetation and created new sites for founding of plant communities. Sediment deposition in the project area is now restricted to a few, largely ephemeral, mid-channel bars and transitory lateral bars proximal to the river. Meander cut-off and lateral meander migration no longer occur. Bare soil sites are now created primarily through mechanical disturbance or fire, typically in areas no longer subject to periodic inundation and with relatively dry soil moisture regimes (Pittenger 2003) (**Figure 2.26B**).

Non-native plant species have become prominent in the bosque. Salt cedar (*Tamarix ramosissima*) is now a prominent colonizer of exposed, bare soil sites in the bosque (Smith et al. 2002). Salt cedar produces seed for several months beginning in spring whereas cottonwood (*Populus deltoides wislizenii*) produces seed only for a short time in the spring, which remains viable for only about month and a half under ideal conditions (Ware and Penfound 1949, Horton et al. 1960). The flowering and fruiting phenology of salt cedar allows seedlings to establish on and dominate open sites wetted by runoff, rainfall, or river flows during the summer, precluding the possibility of cottonwood establishment on potentially suitable sites the following spring.

Fire was virtually unknown in naturally functioning, low-elevation riparian ecosystems of the Southwest (Busch and Smith 1993, Steuver 1997). However, fuel accumulations coupled with mainly human-caused ignitions have introduced fire as a major disturbance mechanism in the bosque ecosystem (Steuver 1997). While cottonwood is highly susceptible to fire-induced mortality, salt cedar re-sprouts vigorously following fire (Busch and Smith 1993, Busch 1995). Native cottonwood and willow (*Salix* species) are poorly adapted to fire and lack an efficient post-fire re-sprouting mechanism such as that found in salt cedar (Busch and Smith 1993). Post-fire soils typically have significantly higher salinity than soils of unburned areas, which may suppress growth of cottonwood and willow seedlings and allow establishment of salt cedar seedlings (Busch and Smith 1993).

Russian olive (*Eleagnus angustifolia*) is established by seed in the understory of mature cottonwood stands and also colonizes openings along the river, often forming dense stands (Hink and Ohmart 1984, Sivinski et al. 1990). Russian olive is shade tolerant. Seeds germinate in moist to dry sites and the plant sprouts readily from the root crown after damage to or removal of above-ground portions of the plant (Sivinski et al. 1990). Russian olive was present in the bosque in 1981 (Hink and Ohmart 1984) and continues to increase in the understory of the cottonwoods in the Study Area (Sivinski et al. 1990).

Several other non-native tree species, in addition to salt cedar and Russian olive, are at least locally common, if not abundant. These species are Siberian elm, tree of heaven (*Ailanthus altissima*), and mulberry (*Morus alba*). All three species are shade-tolerant and readily colonize disturbed sites (Crawford et al. 1993, Sivinski et al. 1990). Siberian elm was rare in the bosque in 1981 when it was found only at very low densities, ranging from less than 1.2 trees/ha (0.5 trees/ac) to 7.4 trees/ha (3 trees/ac) (Hink and Ohmart 1984). However, Siberian elm had become increasingly abundant by 1990 (Sivinski et al. 1990) and is now very common in the overstory. This species produces large seed crops and is ubiquitous in the Study Area as seedlings, saplings, and mature trees. It sprouts readily from the root crown. Siberian elm seed would germinate under normal rainfall conditions and does not require moist or saturated soils (Sivinski et al. 1990). Tree of heaven and mulberry are more localized in their distribution in the Study Area than salt cedar, Russian olive, or Siberian elm. Both of these species typically colonize disturbed areas, such as along levees and in severely burned sites (Sivinski et al. 1990).

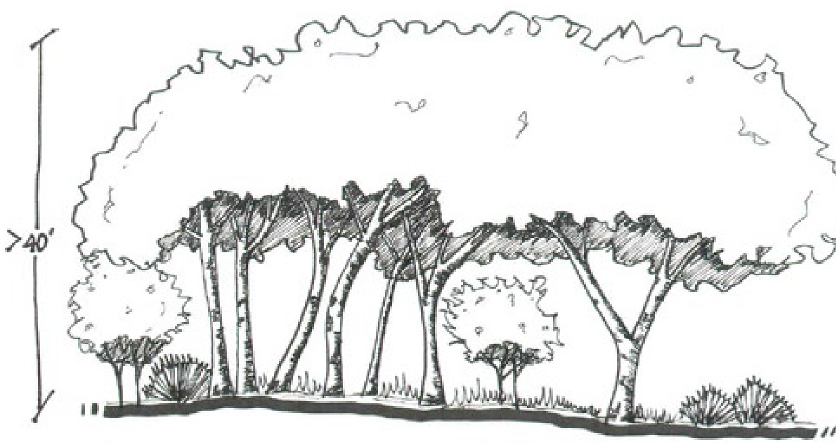
The following description of vegetation in the Study Area uses plant community designations developed by Hink and Ohmart (1984) and mapping by Sivinski et al. (1990), updated with mapping completed in 2002 by the USBOR and in 2005 by Corps. Hink and Ohmart (1984) defined six structure types based on vertical foliage density. Structure Type I consists of tall trees (ca. 50 ft) with a relatively dense understory of saplings and shrubs (**Figure 2.27**). Type II Structure is also composed of tall trees but with little or no sapling and shrub understory (**Figure 2.28**). Type III Structure consists of mid-size trees (less than 30 ft) and dense understory vegetation (**Figure 2.29**). Type IV Structure is characterized by open stands of mid-sized trees with widely scattered shrubs and sparse herbaceous growth (**Figure 2.30**). Type V Structure is dense, short-stature trees and saplings to about 15 feet height, often with dense herbaceous growth (**Figure 2.31**). Type VI structure is scattered plant growth with foliage not exceeding about five feet in height above the ground (**Figure 2.32**).

Type I Vegetation – Mature Riparian Forest with trees 50-60 ft; closed canopy, established understory; vegetation in all layers.

Mature Riparian Forest-Over 40', closed canopy, established understory

Overstory:	Cottonwood, elm (18"-5' diameter trunk)
Understory:	Russian olive, salt cedar, coyote willow, mulberry, New Mexico olive
Fuel load:	Medium to high
Fuel Hazard:	Medium

Figure 2.27 Hink and Ohmart Type I Vegetation



Type II Vegetation – Mature Riparian Forest with trees over 40 ft; nearly closed canopy, limited understory

Mature Riparian Forest-Over 40', nearly closed canopy, limited understory

Overstory:	Cottonwood, elm
Understory (sparse):	Russian olive, salt cedar, coyote willow
Fuel load:	Medium
Fuel hazard:	Low

Figure 2.28 Hink and Ohmart Type II Vegetation

Type III Vegetation – Intermediate aged riparian woodland; closed canopy; dense understory

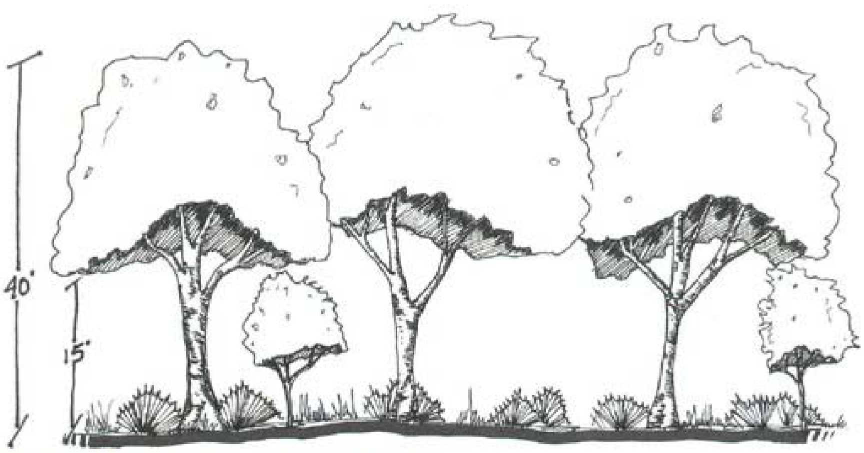
Intermediate Aged Riparian Woodland - Closed canopy, lots of salt cedar and Russian olive

Overstory: Cottonwood, Russian olive, tree willow, elm

Understory: Russian olive, salt cedar, coyote willow, elm, mulberry

Fuel load: High
Fuel Hazard: High

Figure 2.29 Hink and Ohmart Type III Vegetation



Type IV Vegetation – Intermediate aged riparian woodland/savannah; broken canopy; mostly grass

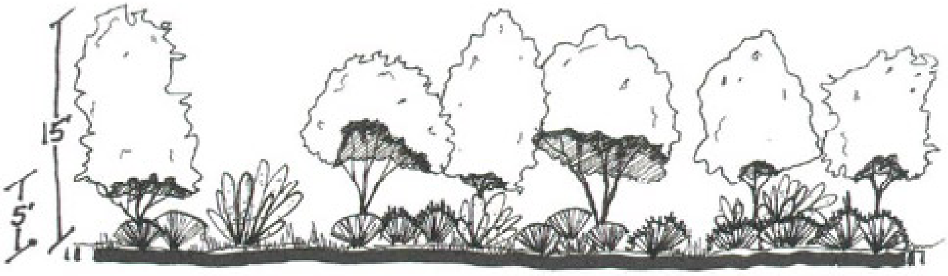
Intermediate Aged Riparian Woodland/Savannah-Broken canopy, mostly grass understory

Overstory: Cottonwood, Russian olive, tree willow, salt cedar

Understory (sparse): Coyote willow, Russian olive, salt cedar

Fuel load: Low
Fuel hazard: Low

Figure 2.30 Hink and Ohmart Type IV Vegetation



Type V Vegetation – Riparian Shrub up to 15 ft; dense vegetation but no tall trees

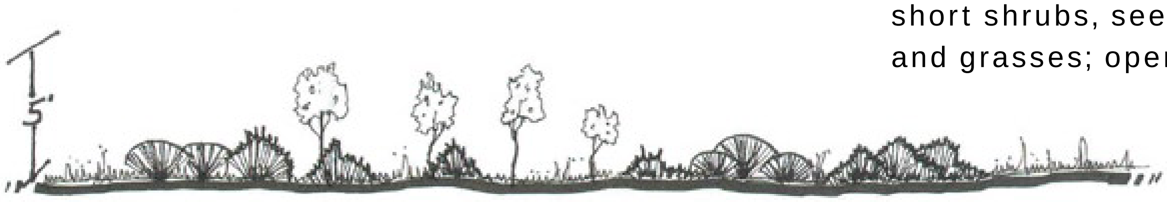
Riparian Shrub-No tall trees

Overstory: Russian olive, salt cedar, coyote willow

Fuel load: High
Fuel hazard: High
(Hink & Ohmart, 1984)

Figure 2.31 Hink and Ohmart Type V Vegetation

Type VI Vegetation – Sparse vegetation with short shrubs, seedlings and grasses; open areas



Short shrubs/Grasses - Open areas and marsh

Urderstory: Cattails, small shrubs and trees

Fuel load: Low
Fuel hazard: Low

Figure 2.32 Hink and Ohmart Type VI Vegetation

Open areas were usually sand bars that are intermittently washed away by the river and don't maintain a large amount of vegetation. Based on 2002 mapping, vegetation in the project area was dominated by old (Structure Type I, 51.6% and Structure Type II 18.18%) and Type V stands (14.04%) stands. Structure Type III stands, which have mid-size trees and a dense understory, covered about 7.38% of the Study Area. Structure Type IV made up only 1.82 % of the vegetation in the Study Area in 2002 while Open areas made up almost 7%. Wetland habitat (Type VI wet) made up only .06% (0.25 acres) of the Study Area. In 2003, part of the Study Area was burned in a fire (south of I-40 on both sides of the river) and efforts to thin other areas of the bosque within the Study Area were undertaken as a fire prevention strategy. Based on the changes from the fire and thinning that occurred, structure types were converted as follows (based on 2005 mapping): Type I – 9.89%, Type II – 55.45%, Type III –3.45%, Type IV – 7.59%, Type V – 12.32%, Type VI – 2.99%, Type VI wet - 1.83%, and Open - 6.5%. Additional thinning occurred between 2005-2007 to help reduce fire potential. Structure types based on the 2007 mapping changed slightly from 2005 as follows and are also shown in **Table 2.7**. Type I existing acreage remained the same. Type II increased by 22 acres (changing from Open, Type III, IV, and VI). Type III increased by 3 acres (from Type V). Type IV increased by 1.5 acres (from Open).Type V increased by 11 acres (from Open). Type VI increased by 20 acres (from Type IV). Percentage changes are shown in **Table 2.7.** This is the current status in the Study Area.

Type II stands in the project area consists of mature, closed canopy stands dominated by Rio Grande cottonwood (*Populus deltoides wislizenii*) and Siberian elm. Cottonwood dominated 89.4% of the Type II stands, while Siberian elm was the dominant overstory tree in at least 10.6% of the Type II stands. However, Siberian elm was present in the overstory and understory of all cottonwood-dominated type II stands in the Study Area. Much of the non-native understory of Russian olive, salt cedar and tree of heaven was removed during the thinning in 2003-2004. Other non-native trees found in the Study Area as minor components of the vegetation were mulberry, northern catalpa (*Catalpa speciosa*), black locust (*Robinia pseudo-acacia*), Osage orange (*Maclura pomifera*), and green ash (*Fraxinus pennsylvanica*). Most of these species were left during thinning efforts.

Although typically not as abundant as non-native species, native shrubs and trees were also found in the understory of type II stands. Gooding's willow (*Salix goodingii*) and New Mexico olive (*Forestiera neomexicana*) were found scattered throughout the Study Area in Type II stands. These species were locally common, often at well-lighted sites in canopy gaps and along the edges of closed-canopy stands. Golden currant (*Ribes aureum*) was also locally common in dense patches. Virginia creeper (*Parthenocissus inserta*) was common throughout the understory, and false indigo bush (*Amorpha fruticosa*) was found scattered throughout the understory of Type II stands. The recently thinned Type II stands were sparse in understory vegetation, but Russian olive, salt cedar and Siberian elm sprouts are prevalent along with the native understory shrubs listed above. The remaining Type V and VI stands were dominated by saplings of tree species or by riparian shrubs. Cottonwood-dominated Type V and VI stands occurred at two sites, both of which were pole planting areas. In 2003-2004, Corps also planted some understory shrubs under the Bosque Wildfire Project north and south of Central on the east side of the river. These plantings included New Mexico olive, golden currant, sumac (*Rhus* spp.), and false indigo bush.

Table 2.7 lists the changes in vegetation structure in the Study Area as a result of the thinning conducted in 2003-2007.

Table 2.7 Changes in Vegetation Structure in the Study Area

STRUCTURE TYPE	Pre-Clearing Acres (2002)	%	Post-Clearing Acres (2005)	-%	Post-Clearing Acres (2007)	-/+%
I	198.8	51.61%	38.45	9.89%	38.45	9.89%
II	70.05	18.18%	213.85	55.45%	235.85	61.19%
III	28.42	7.38%	14.28	3.45%	15.28	3.96%
IV	6.96	1.82%	28.93	7.59%	0.43	0.11%
V	54.11	14.04%	47.50	12.32%	55.5	14.40%
VI	0	0.00%	11.53	2.99%	24.53	6.36%
VI(a) (Wet Habitat)	0.25	0.06%	6.61	1.83%	6.61	1.71%
Open	16.92	4.39%	20.71	5.53%	5.21	1.35%
Open (Wet Habitat)	9.93	2.52%	3.58	0.95%	3.58	0.94%
TOTAL	385.44	100.00%	385.44	100.00%	385.44	100.00%

Jurisdictional wetlands have been found at numerous locations in the Study Area (**Figure 2.29**). Jurisdictional wetlands were present in at least portions of the willow swale on the east side of the river between the Central Avenue and I-40 crossings. These wetlands were characterized by shallow depth to water, saturated soils near the surface, organic-streaked sandy soils below about 10 inches, and vegetation dominated by coyote willow, cottonwood, inland saltgrass (*Distichlis spicata*), and Russian olive. A recreational trail was located through the center of the willow swale.

Two small wetlands were found in the old Atrisco Diversion sluice channel on the west side of the river between the Central Avenue and I-40 crossings (**Figure 2.29**). Other wetland areas were found along the margins of established river bars (**Figure 2.29**). These wetlands were dominated by herbaceous hydrophytic species, had saturated soil in the upper 12 inches, and sandy soils with organic streaking. Jurisdictional wetlands were also present on mid-channel bars in the Rio Grande and are shown in **Figure 2.29** though the project does not involve any work in the river channel.

Figure 2.33 Location of Wetlands within the Study Area (Updated with information courtesy of NMISC and SWCA, 2007)

2.7.2 Fish and Wildlife

An estimated 407 species of vertebrates may occur in aquatic, semi-aquatic, or riparian habitat in Bernalillo County, based on a query of the Biota Information System of New Mexico (accessed March 2008). This estimate includes 24 species of fish, 11 amphibian taxa, 39 species of reptiles, 279 species of birds, and 54 mammalian taxa (Pittenger 2003). Birds are the most important group, based on number of taxa, comprising 69 percent of all vertebrate species in the estimate.

Common fish species in the Study Area include river carpsucker (*Carpiodes carpio*), flathead chub (*Platygobio gracilis*), mosquitofish (*Gambusia affinis*), and red shiner (*Cyprinella lutrensis*; Platania 1993). Less common fish species in the Study Area include longnose dace (*Rhinichthys cataractae*), channel catfish (*Ictalurus punctatus*), fathead minnow (*Pimephales promelas*), white sucker (*Catostomus commersoni*), and Rio Grande silvery minnow (*Hybognathus amarus*).

Of the 18 herptile species found in the bosque ecosystem during pitfall trapping, Hink and Ohmart (1984) found only three to be widespread and common. These species were eastern fence lizard (*Sceloporus undulatus*), New Mexico whiptail (*Cnemidophorus neomexicanus*), and Woodhouse's toad (*Bufo woodhousii*). Herptile abundance and diversity was found to be greatest in habitats that lacked dense canopy cover and that were characterized by sandy soils and sparse ground cover (Hink and Ohmart 1984). Many of the species taken in the bosque were representative of drier upland habitats. Also, the sampling method did not adequately represent aquatic or wetland-associated species. Hink and Ohmart (1984) did describe a distinct assemblage of species associated with denser vegetation cover in mesic or hydric habitats, which included tiger salamander (*Ambystoma tigrinum*), western chorus frog (*Pseudocris triseriata*), bullfrog (*Rana catesbeiana*), northern leopard frog (*Rana pipiens*), Great Plains skink (*Eumeces obsoletus*), New Mexico garter snake (*Thamnophis sirtalis dorsalis*), western painted turtle (*Chrysemys picta bellii*), and spiny softshell turtle (*Trionyx spiniferus*). Studies done by Bateman et. Al (2008) found that eastern fence lizards and New Mexico whiptails increased in relative abundance after non-native plants were removed. The study indicated that perhaps, removing non-native plants in the understory allows more opportunities for heliothermic lizards to bask in areas where light does penetrate the cottonwood canopy.

Common small mammals in the Study Area are white-footed mouse (*Peromyscus leucopus*), western harvest mouse (*Reithrodontomys megalotis*), house mouse (*Mus musculus*), tawny-bellied cotton rat (*Sigmodon fulviventer*), and rock squirrel (*Spermophilus variegatus*). Large mammals found in the Study Area include beaver (*Castor canadensis*), raccoon (*Procyon lotor*), and muskrat (*Ondatra zibethinus*) in aquatic and wetland habitats and porcupine (*Erethizon dorsatum*), long-tailed weasel (*Mustela frenata*), striped skunk (*Mephitis mephitis*), rock squirrel, Botta's pocket gopher (*Thomomys bottae*), coyote (*Canis latrans*), and common gray fox (*Urocyon cinereoargenteus scottii*) in riparian woodlands (Hink and Ohmart 1984, Campbell et al. 1997). Small mammals were found to be more abundant in moister, densely vegetated habitats and those with dense coyote willow than at drier sites (Hink and Ohmart 1984). Hink and Ohmart (1984) described assemblages of small mammals associated with different habitat types. Crawford's desert shrew (*Notiosorex crawfordi crawfordi*) and white-footed mouse were associated with moist forest and woodland habitats. Well-vegetated, grassy habitats and emergent wetlands were occupied by western harvest mouse, plains harvest mouse, house mouse, tawny-bellied cotton rat, and New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Deer mouse (*Peromyscus maniculatus*) was associated mainly with dry cottonwood forest habitat. Open salt cedar habitat had four small mammal species typically found in dry upland habitats: silky pocket mouse (*Perognathus flavus*), Ord's kangaroo rat (*Dipodomys ordii*), Merriam's kangaroo rat (*Dipodomys merriami*), and northern grasshopper mouse (*Onchomys leucogaster*).

Hink and Ohmart (1984) recorded 277 species of birds in the bosque ecosystem. Highest bird densities and species diversity were found in edge habitat vegetation with a cottonwood overstory and an understory of Russian olive or coyote willow in Structure Types I, III, and IV (Hink and Ohmart 1984). Studies done by Finch and Hawksworth (2006) indicate that bird densities of the mid-story nest guild show declining trends following treatment and removal of invasive plant species. Removal of some invasive plant species reduces the availability of nesting and foraging substrates for bird species that use the mid-story layer of habitat. Emergent marsh and other wetland habitats also had relatively high bird density and species richness. Common species in cottonwood habitats in spring and summer included Mourning Dove (*Zenaida macroura*), Black-chinned Hummingbird (*Archilochus alexandri*), Gambel's Quail (*Callipepla gambelii*), Northern Flicker (*Colaptes auratus*), Ash-throated Flycatcher (*Myiarchus cinerascens*), European Starling (*Sturnus vulgaris*), American Robin (*Turdus migratorius*), Northern Oriole (*Icterus galbula*), Black-headed Grosbeak (*Pheucticus melanocephalus*), Lesser Goldfinch (*Carduelis psaltria*), Rufous-sided Towhee (*Pipilio erythrophthalmus*), Blue Grosbeak (*Guiraca caerulea*), Yellow-billed Cuckoo (*Coccyzus americanus*), Lazuli Bunting (*Passerina amoena*), Indigo Bunting (*Passerina cyanea*), and Brown-headed Cowbird (*Molothrus ater*).

Thirteen bird species were found to be limited in distribution to particular habitats during the summer, or breeding season. Nine of these species were associated with aquatic or wetland habitats: Pied-billed Grebe (*Podilymbus podiceps podiceps*), Snowy Egret (*Egretta thula brewsteri*), Virginia Rail (*Rallus limicola limicola*), Sora (*Porzana carolina*), American Coot (*Fulica americana americana*), Killdeer (*Charadrius vociferus vociferus*), Spotted Sandpiper (*Actitis macularia*), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), and Black Phoebe (*Sayornis nigricans semiatra*). The other four species were strongly associated with cottonwood forest habitat: Great-horned Owl (*Bubo virginianus*), Hairy Woodpecker (*Picoides villosum*), Lewis's Woodpecker (*Melanerpes lewis*), and Mountain Chickadee (*Poecile gambeli gambeli*). Thirty of the 46 species of breeding birds found in the bosque used cottonwood forest habitat. No bird species showed a strong preference for Russian olive stands (Hink and Ohmart 1984). However, when Russian olive was present as a component of the understory in cottonwood stands, it appeared to influence the quality of those stands for birds.

More recent bird sampling in Rio Grande Valley State Park found 62 species in winter and 90 during the breeding season (Stahlecker and Cox 1997). The 10 most common species in winter 1996-1997 were Dark-eyed Junco (*Junco hyemalis*), American Crow (*Corvus brachyrhynchos*), American Goldfinch (*Carduelis tristis*), White-crowned Sparrow (*Zonotrychia leucophrys*), American Robin, Canada Goose (*Branta canadensis*), Red-winged Blackbird (*Agelaius phoeniceus*), Mallard (*Anas platyrhynchos*), European Starling, and House Finch (*Carpodacus mexicanus*). Of the 90 bird species found in summer in Rio Grande Valley State Park, only 31 were found in the Study Area, of which 15 were considered to be nesting there (Stahlecker and Cox 1997). The ten most common species in the bosque in summer 1997 were Black-chinned Hummingbird, Red-winged Blackbird, Black-headed Grosbeak, Spotted Towhee (*Pipilio maculatus*), Brown-headed Cowbird, Mourning Dove, Bewick's Wren (*Thryomanes bewickii*), Black-capped Chickadee (*Poecile atricapillus*), House Finch, Cliff Swallow (*Hirundo pyrrhonota*), and European Starling. The greatest number of species and highest bird density in both winter and summer was found in emergent marsh habitat. The most abundant bird species found along the river in winter were Mallard, Canada Goose, and Wood Duck (*Aix sponsa*), which were also found breeding throughout Rio Grande Valley State Park, although in lesser numbers, in summer (Stahlecker and Cox 1997).

Red-tailed Hawk (*Buteo jamaicensis*) and Cooper's Hawk (*Accipiter cooperii*) were reported as common raptors along the river in winter (Stahlecker and Cox 1997). Cooper's Hawk and Great-horned Owl also occur as nesting birds in the Study Area (W. DeRagon, personal communication 2003). Twenty-eight stick nests were found in the Study Area in Spring 2003. All of the stick nests were located in Rio Grande cottonwood; none was found in Siberian elm. Stick nests in the Study Area are used by Great-horned Owl, Cooper's Hawk, Red-tailed Hawk, and American Crow.

The Bald Eagle (*Haliaeetus* leucocephalus) is also known to be present in the proposed project area. This bird species migrates and winters from the northern border southward regularly to the Gila, lower Rio Grande, middle Pecos, and Canadian river valleys (Hubbard 1985a). Bald Eagles are typically associated with water and riparian habitat. These eagles night-roost in groups in sheltered, forested habitats, such as canyons (New Mexico Department of Game and Fish 1988). Suitable foraging habitat is characterized by open expanses of water with abundant prey, such as waterfowl and fish, and large trees or snags for perch sites.

Bald Eagle may occur in winter along the Rio Grande, particularly to the north and south of the Study Area (Stahlecker and Cox 1997: 17). No winter roosts are known from the Study Area, likely due to unsuitable conditions created by the existing level of human disturbance (Stahlecker and Cox 1997: 22).

2.8 Special-Status Species

Thirteen species that are known to occur in plains mesa grassland in riparian, aquatic, or wetland habitat and whose known distribution includes the Study Area were considered as potentially affected by the Preferred Alternative. Four of these 13 species are listed or are candidates for listing under the Federal Endangered Species Act: Rio Grande silvery minnow (*Hybognathus amarus*, endangered), Yellow-Billed Cuckoo (*Coccyzus americanus occidentalis*, candidate), Southwestern Willow Flycatcher (*Empidonax traillii extimus*, endangered), and New Mexico meadow jumping mouse (*Zapus hudsonius luteus*, candidate). Critical habitat for the Rio Grande silvery minnow exists within the Study Area.

Of the remaining nine species, three are state-listed: Neotropic Cormorant (*Phalacrocorax brasilianus*, state threatened), Common Black-hawk (*Buteogallus anthracinus anthracinus*, state-threatened), Bell's Vireo (*Vireo bellii*, state-threatened). The last five species are Federal or state species of concern: flathead chub (*Platygobio gracilis*), Black Tern (*Chlidonias niger surinamensis*), Yuma myotis (*Myotis yumanensis yumanensis*), occult little brown bat (*Myotis lucifugus occultus*), and Pecos River muskrat (*Ondatra zibethicus ripensis*).

The existing conditions of these 13 species within the Study Area are discussed further below.

- **Rio Grande Silvery Minnow -** Rio Grande silvery minnow (*Hybognathus amarus*) historically occurred in the Rio Grande drainage in New Mexico and Texas (Lee et al., 1980; Propst, 1999). The species was historically one of the most abundant and widespread fishes in the Rio Grande drainage (Bestgen and Platania, 1991). In New Mexico, historic range of the species included the Rio Chama from Abiquiu to the Rio Grande confluence, the main stem of the Rio Grande from Velarde downstream to the New Mexico-Texas state line, and the Pecos River downstream from Santa Rosa (Sublette et al., 1990). Rio Grande silvery minnow was extirpated from the Rio Grande downstream of the Pecos River by 1961 and Pecos River proper by the mid-1970s. The species was also extirpated from the Rio Grande upstream from Cochiti Dam and downstream from Elephant Butte Reservoir. One of the greatest threats to its survival is poor water quality (Utton Transboundary Resources Center, 2004). Currently, Rio Grande silvery minnow is present only in the Rio Grande between Cochiti Reservoir and the upper end of Elephant Butte Reservoir, which represents less than 10% of its historic distribution (Bestgen and Platania, 1991; Propst, 1999). Abundance of Rio Grande silvery minnow has declined markedly from 1994 to the present time and the population has become concentrated in the reach of the

Rio Grande between San Acacia Diversion Dam and the headwaters of Elephant Butte Reservoir. Critical Habitat has been designated for the Rio Grande silvery minnow and is within the project area.

Rio Grande silvery minnow is a pelagic-broadcast spawner, producing nonadhesive, semi-buoyant eggs (Platania and Altenbach, 1998). Spawning is initiated by elevated stream discharge and occurs primarily in the late spring and early summer, when water temperatures are 68^{o}F to 75^{o}F (Propst, 1999). Females may produce three to 18 clutches of eggs, each clutch numbering from 200 to 300 eggs. Growth to maturation occurs in about two months. Rio Grande silvery minnow typically live only about one year, with less than 10% of the adult population surviving to up to two years (Platania and Altenbach, 1998; Propst, 1999). Habitat used by adult Rio Grande silvery minnow is characterized by silty to sandy substrate, depths of 8 in to 2.6 ft, and slow to moderate current velocity, 0 ft/sec to 0.98 ft/sec; (Dudley and Platania, 1997). Habitats with slow current velocity and associated cover are used in winter. Rio Grande silvery minnow feeds on algae and detritus (Propst, 1999; USFWS, 1999). Major threats to persistence of Rio Grande silvery minnow include diminution of river flows and dewatering by surface water diversions and dam regulation, modification of aquatic habitats that result in faster current velocities and narrower channels, and introduction of nonnative fishes (USFWS, 1999). Recovery of Rio Grande silvery minnow requires stabilizing the population in the Middle Rio Grande and reestablishing the species in suitable habitats within its historic range (USFWS, 1999). Over the 2004 and 2005 monitoring season, a large population of Rio Grande silvery minnow was found in the Albuquerque Reach of the Middle Rio Grande.

Dudley and Platania (1997) documented habitat preferences of Rio Grande silvery minnow. They found that individuals were most commonly collected in shallow water (<40 centimeters [cm]) with low water velocities (<10 cm/second [cm/s]) and small substrate size, primarily silt and sand. Low-velocity habitats, such as backwaters and embayments, provide nursery areas for larvae (Dudley and Platania 1997, Massong et al. 2004), which grow rapidly in these areas. Restoration efforts that increase the availability of these habitat conditions would benefit Rio Grande silvery minnow. In addition to the quantity of preferred habitat, food availability may be influenced directly by river restoration activities. Rio Grande silvery minnow are herbivores that eat primarily diatoms, cyanobacteria, and green algae associated with sand or silt substrates in shallow areas of the river channel (Shirey 2004).

Recent research (Pease et al 2006; Porter and Massong 2004, 2006; Bureau of Reclamation 2007; SWCA 2007) indicates nursery habitat on inundated pointbars, islands, and the floodplain provide essential conditions for spawning, with survival of RGSM eggs and larvae. Increased recruitment during average spring flow result in increased fall populations (US Army Corps of Engineers 2007), supporting the value of habitat restoration and hydrograph management for producing RGSM in the river.

Currently, *Hybognathus amarus* is the only remaining endemic minnow with semi-buoyant eggs in the Middle Rio Grande. The peglagic spawning speckled chub (*Extrarius aestivalus*), Rio Grande shiner (*Notropis jemezanus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus simus*) are either extinct or have been extirpated from the Middle Rio Grande (Bestgen and Platania 1991).

The remaining population of the silvery minnow is restricted to approximately 5 percent of its historic range. Every year since 1996, there has been at least one drying event in the river that has negatively affected the silvery minnow population. The population is unable to expand its distribution because poor habitat quality and Cochiti Dam prevent upstream movement and Elephant Butte Reservoir blocks downstream movement (USFWS, 1999). Augmentation of silvery minnows with captive-reared fish will continue, however, continued monitoring and evaluation of these fish is necessary to obtain information regarding the survival and movement of individuals.

Several habitat restoration projects have been completed in the Albuquerque reach through the Collaborative Program. These projects include two woody debris installation projects to encourage the development of pools and wintering habitat, and a river bar modification project south of the I-40 Bridge designed to create side and backwater channels on an existing bar as well as modify the top surface of the bar to create habitat over a range of flows. Additionally, in 2005, the ISC started a multi-year habitat restoration program that implements several island, bar, and bank line modification techniques throughout the Albuquerque Reach. Approximately 24 acres of habitat were restored in the Phase I. Phase II is scheduled to begin in winter 2007. In April 2008, the Corps completed the Rio Grande Nature Center Habitat Restoration Project reconnecting an ephemeral side channel to the river for silvery minnow habitat.

Various conservation efforts have also been undertaken in the past and others are currently being carried out in the middle Rio Grande. Silvery minnow abundance has increased since 2003 population levels as a result of several years with average spring flows. The increased abundance of silvery minnow from 2004-2007 is a positive sign. Releases of captive-reared Rio Grande silvery minnow have been made at Central bridge, which is within the Study Area.

- **Flathead Chub** - This fish species occurs in west central North America from the lower Mississippi River and tributaries of the South Canadian River in Oklahoma, north to Lake Winnipeg and Saskatchewan and Mackenzie river drainages in Canada. In New Mexico, the species is native to the Rio Grande, Pecos, and Canadian drainages including the Dry Cimarron drainage. Flathead chub populations are expanding in the Rio Grande drainage and stable in the Pecos and Canadian (including the Dry Cimarron River) drainages. Flathead chub is found in perennial streams and is associated with main-channel habitats characterized by shifting sand substrates and typically turbid water (Sublette et al. 1990). Flathead chub is abundant in the Rio Grande in the Study Area (USFWS 1999: 15).

- **Neotropic Cormorant** - This bird species occurs from southern New Mexico to southern Louisiana, southward through Central America and parts of the Caribbean region to southern South America. Vagrants occur elsewhere, including further north in the United States (American Ornithologist's Union 1983). In New Mexico, the species breeds and is variably resident in the Rio Grande Valley at Elephant Butte and Caballo lakes. It also occurs regularly at Bosque del Apache National Wildlife Refuge (Hubbard 1978). All of these locations are key habitat areas where the species is known to breed. The species also occurs occasionally as non-breeding individuals in the Rio Grande Valley northward to the Bernalillo area, southward to Las Cruces, and in the Gila Valley. They nest near or over water, in vegetation such as snags or trees. Stahlecker and Cox (1997: 25) reported Double-Crested Cormorant (*Phalacrocorax auritus*) in the Study Area in winter and summer, but no Neotropic Cormorants. Neotropic Cormorant may occur in the Study Area but are unlikely to breed there due to lack of suitable lacustrine habitat.

- **Common Black-Hawk** - This bird species is known to breed in southwestern New Mexico, east-central to southeastern Arizona, western Texas, and the lower Rio Grande Valley and Gulf of Mexico coast in southeastern Texas (Clark and Wheeler 1987: 48). Most birds migrate south to winter, although some winter records are reported from southern Arizona and the Gulf coast in Texas. In New Mexico, Common Black-Hawk breeds along the lower elevations of the Gila, San Francisco, and Mimbres rivers

(Hubbard and Eley 1985). The species has also been reported as breeding along the Rio Grande north to Albuquerque (Hundertmark 1974) and, more recently, in the Hondo Valley in Lincoln County (D. W. Stahlecker, personal communication 2003). Only one occurrence of nesting Common Black-Hawk has been reported from the vicinity of the Study Area (in 1989 in the south end of the City near Rio Bravo Blvd.) (Hoffman, 1990).

- **Black Tern** - This bird species occurs irregularly in summer in northern New Mexico, the Rio Grande Valley, and the Pecos Valley. This tern migrates statewide and is considered rare to fairly common locally. Black Tern occurs most frequently in summer in the San Juan Valley, Jicarilla Apache Indian Reservation, the middle Rio Grande Valley, and at Bitter Lake National Wildlife Refuge (Hubbard 1978). The Black Tern migrates along the Middle Rio Grande through the Study Area, but does not nest in the Study Area (R. Floyd, pers. comm.., 2008)

- **Yellow-Billed Cuckoo** - The breeding range of this bird species extends from California and northern Utah eastward to southwestern Quebec and south to Mexico. Yellow-Billed Cuckoo has declined precipitously throughout its range in southern Canada, the United States, and northern Mexico. The number of breeding birds has declined by about 42 percent in the eastern United States (Elphick et al. 2001: 335). Its only remaining western “strongholds” are three small populations in California, scattered populations in Arizona (especially on the San Pedro River) and New Mexico (especially the Gila River), and an unknown number of birds in northern Mexico (Center for Biological Diversity 2000). The species winters in South America (DeGraaf et al. 1991).

  Both Hink and Ohmart (1984) and Stahlecker and Cox (1997) reported Yellow-Billed Cuckoo as a nesting bird in the bosque of the Middle Rio Grande, although none of these reports was from the Study Area. Habitat potentially suitable for nesting of Yellow-Billed Cuckoo is present in the Study Area, primarily in the form of dense salt cedar stands.

- **Southwestern Willow Flycatcher** - The Southwestern Willow Flycatcher (flycatcher) is found in the U.S. from May until September. It winters in southern Mexico, Central America, and northern South America (Unitt, 1987). In New Mexico, the Southwestern Willow Flycatcher is distributed in nine drainages (Gila, Rio Grande, Rio Chama, Coyote Creek, Nutria Creek, Rio Grande de Ranchos, Zuni, Bluewater Creek, and San Francisco). The flycatcher is an endangered species on the U.S. Fish and Wildlife Service Endangered Species List and critical habitat has been designated in the Middle Rio Grande, though not in the proposed project area. As of 1996, it was estimated that there were only about 400 Southwestern Willow Flycatchers in New Mexico, representing about 42% of the total population of the subspecies (Southwestern Willow Flycatcher Recovery Team, 2002). Southwestern Willow Flycatchers occur in riparian habitats along rivers, streams, or other wetlands, where dense growth of willows (*Salix* spp.), *Baccharis*, arrowweed (*Pluchea* sp.), saltcedar or other plants are present, often with a scattered overstory of cottonwood (Unitt 1987; Sogge et al., 1997; Finch and Stoleson, 2000). These riparian communities provide nesting and foraging habitat. Throughout the range of Southwestern Willow Flycatcher, these riparian habitats tend to be rare, widely separated, small and often linear locales, separated by vast expanses of arid lands. The Southwestern Willow Flycatcher is endangered by extensive loss and modification of suitable riparian habitat and other factors, including brood parasitism by the Brown-Headed Cowbird (*Molothrus ater;* Unitt, 1987).

  The Southwestern Willow Flycatcher is an obligate riparian species and nests in thickets associated with streams and other wetlands where dense growth of willow, Russian olive, saltcedar, or other shrubs is present. Nests are frequently associated with an overstory of scattered cottonwood. Southwestern Willow Flycatchers nest in thickets of trees and shrubs approximately 6 to 23 feet in height or taller, with a densely vegetated understory approximately 12 feet or more in height. Surface water or saturated soil is usually present beneath or next to occupied thickets (Muiznieks et al. 1994). At some nest sites, surface water may be present early in the breeding season with only damp soil present by late June or early July (Muiznieks et al. 1994). Habitats not selected for nesting include narrow (less than 30 feet wide) riparian strips, small willow patches, and stands with low stem density. Suitable habitat adjacent to high gradient streams does not appear to be used for nesting. Areas not utilized for nesting may still be used during migration.

Breeding pairs have been found within the Middle Rio Grande from Elephant Butte Reservoir upstream to the vicinity of Española. Southwestern Willow Flycatchers begin arriving in New Mexico in early May.   Breeding activity begins immediately and young may fledge as soon as late June. Late nests and re-nesting attempts may not fledge young until late summer (Sogge et al. 1997).

Occupied and potential Southwestern Willow Flycatcher nesting habitat occurs within the Middle Rio Grande valley. Occupied and potential habitat is primarily composed of riparian shrubs and trees, chiefly Goodding's willow and peachleaf willow, Rio Grande cottonwood, coyote willow, and saltcedar. The nearest known breeding Southwestern Willow Flycatchers from the project area occurs along the Rio Grande at Isleta Pueblo. Potential habitat exists adjacent to the proposed project area. Designated Critical Habitat was determined for WIFL in November 2005 but is not in the project area.

- **New Mexico Meadow Jumping Mouse** - This species was listed as a Candidate for listing under the Endangered Species Act in 2007 (72 FR 69034). This species is a small rodent recognized for its extremely long tail and ling hind feet. The New Mexico meadow jumping mouse is endemic to New Mexico, Arizona, and a small area of southern Colorado. The species in New Mexico characteristically occur in mesic habitats dominated by rank, herbaceous vegetation. In both the Jemez Mountains and the Rio Grande Valley, Morrison (1985, 1988) found that preferred habitat for the meadow jumping mouse contained permanent streams, moderate to high soil moisture, and dense and diverse streamside vegetation consisting of grasses, sedges, and forbs. Such habitats were characterized by wet meadows in the Jemez Mountains, while they included the edges of permanent ditches and cattail stands in the Rio Grande Valley (NMDGF, 1988). Breeding occurs in New Mexico variously from May to September, with litters numbering 3-4 young. Only one breeding effort per year appears to occur in the northern part of the state, whereas two litters may be produced in the central Rio Grande Valley (NMDGF, 1988). Reasons for decline include excessive grazing pressure, water use and management, highway reconstruction, development, and recreation. This species' distribution is highly fragmented, which also contributes to its vulnerability and increases the likelihood of very small, isolated populations being extirpated.

New Mexico meadow jumping mouse was collected by Hink and Ohmart (1984) along the Rio Grande only at Isleta Marsh, which is south of the Study Area. Sampling in the Study Area in 1997 failed to find the species there (Campbell et al. 1997). Potentially suitable habitat for New Mexico meadow jumping mouse in the Study Area is restricted to a few small wetlands adjacent to the river.

- **Bell's Vireo** - This bird species breeds from southern California, the Southwest, and the central Great Plains and the adjacent Midwest southward to northern Mexico. The subspecies *Vireo belli arizonae* occurs in parts of the southwestern United States and Sonora, while the subspecies *V. b. medius* occurs to the east (Oberholser 1974). In New Mexico the subspecies *V. b. arizonae* summers locally in the lower Gila Valley and in Guadalupe Canyon (Hidalgo County), with occasional birds in the lower San Francisco Valley and at San Simon Cienega in Hidalgo County (Hubbard 1985c). *V. b. medius* summers very locally in the lower Rio Grande (and as a vagrant north to Albuquerque) and the lower Pecos valleys. In New Mexico, Bell's Vireo characteristically occurs in dense shrubs or woodland along lowland stream courses, with willows, mesquite, and seepwillows being characteristic plant species (Hubbard 1985c). Based on our understanding of the lower, middle and upper Gila Valley, Bell's Vireo also occur in the middle Gila Valley (R. Floyd, pers. comm.., 2008) .Bell's Vireo has not been documented as a breeding bird in the Study Area, and habitat suitable for the species is not found there.

- **Yuma Myotis** - This small mammal species is typically found in grassland, woodland and riparian habitats from 1,220 to 2,130 m (4,000 to 7,000 ft) elevation. This species is most common in desert areas and is closely associated with open water (Schmidly 1991). Yuma myotis forages at the water surface. Railroad bridges and buildings are common summer retreats for this bat (Findley et al. 1975). Yuma myotis may occur in the Study Area. The species was collected at Corrales and several other locations along the Rio Grande upstream and downstream from the Study Area (Findley et al. 1975: 30).

- **Occult Little Brown Bat** - This small mammal species, like Yuma myotis, is a "water" bat in that most specimens have been taken in the vicinity of large permanent water sources such as streams, drainage ditches, or lakes (Findley et al. 1975). Occult little brown bats mate in fall, and fertilization occurs in spring (Barbour and Davis 1967, Humphrey and Cope 1976). Young are born in May or June. As with Yuma myotis, occult little brown bat may occur in the Study Area.

- **Pecos River Muskrat** - This small mammal species is found throughout North America wherever there is adequate water and emergent vegetation (Hall 1981). The historic range of the Pecos River muskrat includes areas within New Mexico and Texas. Muskrats occur in marshes and drainage ditches along the Rio Grande, Pecos, and San Juan rivers. Campbell et al. (1997) observed muskrat tracks at an island near the Montaño bridge and at the Rio Bravo bridge crossing, which are both north and south of the Study Area.

2.9 Cultural Resources

The Cultural Resources Survey Reports are found in Appendix C in the Technical Appendix. What follows is a summary of the cultural landscape setting and findings.

Prior to reclamation efforts and dam construction along the Rio Grande watershed, the channel of the Rio Grande was a wide, ever-changing braided network of waterways. The main channel of the Rio Grande would often shift locations, running along the eastern or western edges of the valley. This pattern of shifting channels affected the location of farmlands marginal to the river and probably accounts for the presence of sister villages or pairs of prehistoric and early historic pueblos that are found along opposite banks of the river. The populations appear to have shifted from one side of the river to the other depending on the location of the channel and the availability of farmlands.

In the early 18th century, the historic main channel of the Rio Grande ran along the eastern edge of the valley from Alameda to the Albuquerque area. Maps of the area in 1675 and 1710 show the Village of Alameda on the west bank of the river, while a map completed in 1766-68 shows the village on the east bank (Sargeant 1987:39). It appears that a major flood that occurred about 1735 caused the channel to move to the western section of the valley near its present channel. Until the construction of the Alameda dikes in the late 19th-early 20th centuries, this eastern channel often carried high, water floods. It is well known that the area was subject to general flooding prior to installation of the levees, and that this old river channel was responsible for flooding downtown Albuquerque in the late 19th-early 20th centuries.

Floods played a major role in the early settlement and land use of the area and often caused the abandonment and relocation of pueblo villages and later Hispanic settlements. Several of these settlements were located on slight elevations in the valley floor and were subject to frequent flooding, or were on low islands surrounded by floodwaters. Many of the older sites and buildings in the valley floor were destroyed or damaged by floods, and others remain buried in the alluvial sediments.

Flooding in the Rio Grande Valley, agricultural development and the more recent urban development in the Albuquerque area have had a considerable effect on the nature, location and preservation of the cultural resources. Many of the archaeological and older historic sites have been destroyed, buried by fluvial action, or extensively modified by later construction and development. Surface visibility of cultural remains is obscured by these actions, and in some areas buried cultural remains are present. Archaeological investigations and cultural resource management projects in the Rio Grande Valley usually require a combination of historic research, archaeological survey, and test excavation or monitoring activities in order to locate and define the cultural resources. The nature and extent of this search methodology depends on the specific location and circumstances of the proposed development. The bosque restoration project is located within the active and historic floodplain of the Rio Grande in an area that has prevented settlement and allowed for only limited farming and grazing uses. A number of bridges and irrigation facilities were built in the area, but floods have destroyed many of these features.

The Rio Grande bosque in the early historic period was dominated by stands of Rio Grande cottonwood and willow thickets and by extensive marshes and swamps populated by sedge, bulrush, cattail, salt grass and other species (Scurlock 1988a:131). The bosque environment was an important ecozone and resource for Native American populations that inhabited the area. It probably saw rather extensive use for gathering riparian plants, hunting bosque and riverine animals, and for collecting fuel wood and construction materials. This use likely began in the Paleoindian-Archaic periods. Use of the bosque environment probably intensified following the development of hamlet villages as early as 1800 B.C. It grew more extensive after the development of Rio Grande Pueblo culture beginning in the 13th century, when large adobe pueblos extended in a chain of at least 80 major villages along the Rio Grande Valley in New Mexico (Schroeder 1979). Native Americans probably set fire to the bosque to clear the area for fields, and this had a major effect on its composition. Nonetheless, it is likely that extensive cottonwood groves extended along the river even during the height of Rio Grande Pueblo civilization, prior to Spanish contact.

The first Europeans to see the Rio Grande Valley near Albuquerque arrived on September 7, 1540, with the Don Francisco Vázquez de Coronado expedition and were the first to describe the valley. They reported, "This river of Nuestra Señora flows through a broad valley planted with fields of maize and dotted with cottonwood groves. There are 12 pueblos, whose houses are built of mud and are two storeys high" (Bolton 1964:184). Following Spanish colonization in 1598 and during the period from the early Spanish occupations of the 17th century to the first entrance of the Americans in the early 19th century, the Rio Grande bosque experienced considerable use and was extensively harvested for firewood and building materials. The earliest descriptions of the valley by Americans reveal a river valley nearly denuded of trees. All of the early photographs of the Albuquerque area show an extremely wide and bare riverside, nearly devoid of trees. A photograph of Tingley Beach under construction in 1930 shows no trees whatsoever along the riverside to the west (Biebel 1986:15). Today, much of this barren riverside is forested and is within the Rio Grande bosque Study Area.

Following the arrival of the railroad in 1880, imported fuels and the use of coal fuel began to increase, somewhat alleviating the use of bosque fuel wood. However, the riverside remained denuded until the 1930s. During the 1920s and 1930s, the riverside was invaded by introduced species such as salt cedar, Russian olive and occasional elm and tree of heaven. Many of the cottonwood stands were reestablished when they were neglected for fuel wood and building materials. Large stands of cottonwood also became reestablished following the control of the river channel by reclamation efforts over the last 80 or so years. These stands are periodically destroyed by destructive fires caused by the accumulation of fuel wood from salt cedar, Russian olive and other understory vegetation.

The invasion of non-native plant species into the Rio Grande bosque—beginning in the early 20th century—had a major effect on the riverside environment. Many of these species escaped from cultivation in the nearby Albuquerque urban neighborhoods. The non-native species that have had the most effect on the bosque environment include salt cedar, Russian olive and, to a lesser degree, Siberian elm, tree of heaven, white mulberry, and black locust.

The cultural resource investigation was conducted under New Mexico State Permit No. 03-045. The objectives of the survey were to identify all cultural resources within the project Study Area and to evaluate the possible effect of the proposed bosque project on these resources. A comprehensive review of cultural-historical records and historical archives was conducted, and previous research in the area was reviewed. A systematic survey of the entire bosque within the riverside drains to the immediate edge of the active river channel was completed.

The cultural resource records search revealed that no cultural properties have been previously identified within the Study Area. A diverse and varied group of historic and archival records for the Study Area and vicinity were consulted in this study as part of the historic information and historic bridge survey documentation. Maps and photographic records were particularly informative. The archaeological survey identified seven cultural resources including three bridge remnants (LA139208, LA138856, LA138857), one probable irrigation diversion structure (LA138858), one site with two adjacent segments of pre-MRGCD irrigation canals (LA138859), one flood control structure (LA138855), and the abandoned Atrisco diversion works (LA138860). Twenty-one isolated occurrences (IOs) were also identified in the Study Area, and include seven fill and dump areas, seven trash dumps, four homeless camps, two other temporary log shelters and one earth bank feature. Full descriptions of remarkable findings are included in the Cultural Resource Survey prepared by Cibola Research Consultants. Subsequent archaeological surveys were conducted covering areas outside of the original survey area. These surveys documented an abandoned segment of the Atrisco Riverside Drain (LA159913; Everhart 2008a) and a historic concrete box culvert identified as the Atrisco Lateral Wasteway (Everhart 2008b). Documentation regarding the archaeological surveys and consultation can be found in Appendix C of the Technical Appendix.

2.10 Socioeconomic Environment and Environmental Justice

The neighborhoods adjacent to the bosque in this part of the City are among the oldest and historically significant communities within Albuquerque. Old Town and Atrisco, in particular, were the original Hispanic farming communities in the area and were intimately tied to the Rio Grande. The Alamosa neighborhood is comparatively recent, but it was among the first to be developed on Albuquerque's west side.

Much of the old heavy industrial core of the City is found in these neighborhoods, which has left a legacy of vacant and underutilized lands such as the rail yards area. Although in many ways these neighborhoods remain the heart and soul of the City, they have not benefited from many of the more recent municipal infrastructure investments. The majority of older storm drains, which are not collected by either of the North or South Diversion Channels, have outfalls located in the bosque adjacent to these neighborhoods. Over time, the large accumulations of trash and the quality of the water at these outfalls have become a source of environmental concern.

There is also a legacy of dumping in the Study Area that dates back to the early days of the City, when the bosque was the edge of town. Early municipal dumps were located inside and adjacent to the Study Area. Dumping of construction debris continued well into the late 20th Century along the levee, especially on the east side of the Study Area north and south of Central. Overall, the relative amount of dumped debris here appears to be greater than other parts of the bosque. Although clean-up efforts have been made, much debris remains.

Six census tracts are located along the Rio Grande between I-40 and Bridge Boulevard. They encompass the following residential neighborhoods.

East of the Rio Grande

- The Barelas neighborhood (census tract 14.00)
- The Country Club and adjacent neighborhoods (census tract 22.00)
- The neighborhoods surrounding Old Town (census tract 26.00)
- The Near North Valley neighborhoods, including Duranes (census tract 25.00)

West of the Rio Grande

- The Atrisco neighborhoods between Central Avenue and Bridge Boulevard to the south (census tract 23.00)
- The Alamosa neighborhoods between Central Avenue and I-40 to the north (census tract 24.01)

2.10.1 Demographics

The information below and in **Figure 2.34** summarizes the U.S. Census Bureau's socio-economic profile (U.S. Census 2000) for the census block groups that correspond to these neighborhoods.

Figure 2.34. Profile of Demographic Characteristics, Census 2000

Neighborhoods along the Bosque	*Population*	*Median Household Income ($)*	*Race (population of Hispanics)*	*Poverty Rates (individuals 18 years and older)*	*Educational Attainment (high school graduates)*
Alamosa	5,268	40,410	79.9%	11.9%	75.0%
Atrisco	7,815	29,768	85.0%	23.0%	57.3%

Barelas	3,270	18,657	86.2%	27.0%	46.6%
Country Club	3,367	29,450	45.4%	17.6%	85.1%
Old Town	1,400	19,605	65.8%	27.0%	64.9%
Near North Valley	1,944	24,040	71.2%	19.7%	72.8%

The Study Area is located within the city limits of Albuquerque, New Mexico in Bernalillo County. The total population of Albuquerque in 2003 was estimated to be 471,856. The total population of Bernalillo County in 2006 was estimated to be 615,099. The total population of the neighborhoods along the bosque makes up approximately five percent of Albuquerque's population. The ethnic background for the city of Albuquerque is: white (non-Hispanic), 71.6%; Hispanic (any race), 39.9%; black (non-Hispanic), 3.1%; American Indian and Alaska Native, 3.9%; and Asian persons, 2.2% (Percentages may add to more than 100% because individuals may report more than one race). In 2000, the median household income for the city of Albuquerque was $38,272. The median household income for Bernalillo County in 2004 was $43,047. The median household income for most of the bosque neighborhoods is well below the citywide and countywide figures. Educational attainment (individuals over the age of 25 who are high school graduates) within the city of Albuquerque in 2000 was 85.9%. Educational attainment in Bernalillo County in 2000 was 84.4%. Educational attainment within the bosque neighborhoods tends to be lower than in the city of Albuquerque as a whole. The exception is in the Country Club neighborhood, where the rates are comparable to the City. In the city of Albuquerque, 14.1% of individuals were below poverty in 2004 and 13.5% of individuals were below poverty in Bernalillo County. Poverty rates for individuals in the bosque neighborhoods are generally much higher than the city and county figures.

2.10.2 Environmental Justice

The planning and decision-making process for actions proposed by Federal agencies involves a study of other relevant environmental statutes and regulations, including Executive Order (EO12898), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* which was issued by President Clinton on February 11, 1994. The essential purpose of EO 12898 is to ensure the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no groups of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, tribal and local programs and policies. Also included with environmental justice are concerns pursuant to EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This EO directs Federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children under the age of 18. These risks are defined as "risks to health or to safety that are attributable to products or substances that the child is likely to come into contact with or ingest."

Environmental justice considerations addressed in this assessment involve both population demographics, including ethnic, racial, or national origin characteristics, and persons in poverty, including children under age 18. In order to determine whether environmental impacts affect minority or low-income populations, it is necessary to establish a basis of comparison, referred to as the "region of comparison." This area consists of the geopolitical units that include the proposed project. Most environmental effects from the Proposed Action, in this instance, would be expected to occur in Bernalillo County, New Mexico.

Executive Order 12898 (Environmental Justice) requires "to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report of the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations…" .

Although no environmental effects are anticipated with respect to the areas adjacent to the bosque, there is an opportunity in the Route 66 Project to improve environmental conditions in the bosque through removal of dumped debris and reconfiguring outfall areas as created wetlands. This would have positive environmental impact on neighboring populations.

2.11 Land Use

Land use in the bosque is limited today to passive recreation and educational uses. Historically, the bosque has a rich legacy as a cultural landscape, which has already been described in detail above. Most of the historic uses have either been outlawed or displaced to adjacent areas. Hunter-gatherer uses such as wood cutting and hunting have been outlawed, although there is evidence of illegal wood cutting just south of Bridge Boulevard on the west side. In addition, grazing and other agricultural pursuits were historically common in the bosque, which probably impacted the nature and type of herbaceous and other understory plants found today in the bosque. The use of the bosque as an irrigation facility began early, as noted above. Evidence of early diversion channels can be found in the bosque, especially on the west side north of Central, of which the Atrisco Diversion Channel is the most prominent example. In addition, the bosque itself is the armor for the conveyance channel that brings the water of the Rio Grande to farmers and communities south of the Albuquerque Reach all the way to the Gulf of Mexico.

As with many bottomlands on the margins of urban areas, the bosque has also long functioned as a dump. Early levee construction and armoring techniques also employed the dumping of large amounts of construction debris. Thus in some places, especially along the east side of the Study Area south of Central, it is hard to distinguish where the levee ends and the dump begins. This use of the bosque continued until relatively recently, with construction debris from as late as the 1980s present in some areas along the levees. On the west side of the Study Area, just north of Central, there are also spoils from ongoing ditch cleaning activities. In general, dumping has been one of the most frequently raised concerns of community members and stakeholders alike, and the AOSD has worked diligently to curb the dumping within the RGVSP limits.

The bosque also unofficially functions as a place of dwelling for homeless people. As of the time of the initial fieldwork for the Route 66 Project (Winter 2003), there were still a number of encampments (see **Figure 2.35 and Figure 2.36**). These ranged from very temporary accommodations to semi-permanent wood and plastic structures, which appear to be mostly seasonally occupied. The highest concentrations of such dwellings were on the west side close to the access points associated with the Central and the Bridge Boulevard bridge and the irrigation outfall. A major homeless encampment area was also found approximately midway between the Central and Bridge Boulevard bridges on the east side near Alcalde Street. These are outlined in pink on Figure 2.32. Since the majority of the area has been initially thinned between 2003-2007 to prevent fires, most of these encampments have been removed.

Figure 2.35 Homeless Encampment

Land use adjacent to the bosque has also changed a great deal over time. Currently, the primary uses are either residential or public in the form of the Albuquerque Biological Park (Zoo, Botanical Garden, and Aquarium) or one of a number of Bernalillo County and City of Albuquerque Parks. Historically, similarly situated floodplain in the Middle Rio Grande areas would have been a mosaic of wetlands, especially salt grass meadows, pasture lands, irrigated croplands and dumps. With the advent of major flood control measures, the active floodplain has been reduced to a tiny sliver; residential and other urban uses have claimed land that was formerly considered undevelopable right up to the riverside drain. The current mosaic of adjacent land uses tends to be patterned by the bridges and more recent commercial uses. Dumps and major industrial areas have become public parks and open spaces (for example the Albuquerque Country Club Golf Course, Kit Carson Park, the Zoo, and the County Open Space that had been the Serna Trucking site). In the vicinity of the Central Avenue and Bridge Boulevard bridges, land uses tend to be commercial or high density residential with lower density residential in between. West of the river on both sides of Central Avenue there are still significant areas of irrigated farmland, pasture and other rural uses. Neighborhoods are working to preserve remaining agricultural open spaces in the face of pressures to develop.

2.12 Interpretive and Recreational Resources

Most of the recreational uses within the bosque constitute passive recreation. Walkers, runners, bicyclists, and birders enjoy the bosque for the experience of nature and wildlife in a pleasant, shady area. Currently the levees are used as trails; there is a paved trail on the east side levee south of Central and along the upland side of the riverside drain from Central to I-40. Over the years, recreational users have made additional trails within the bosque that parallel the levee and intersect with other trails that travel from the levee to the river's edge and back. **Figure 2.36** shows the extent and type of trails in the bosque and access points. River access remains for the most part difficult and unpredictable, except at the major bridges.

Other recreational users include equestrians and mountain bikers. Equestrian use of the bosque has decreased since the levee trail was paved. Nevertheless, riding through the bosque remains a popular pastime, although equestrian use is not as frequent in this particular stretch as it is north of I-40 and south of Bridge Boulevard. Mountain biking is another use of the bosque in the Study Area. For the most part, this activity takes place on existing trails. There is some fishing in the Study Area from the river's shore by the irrigation siphon on the east side midway between Central and I-40, but most fishing is done in the riverside drains and at Tingley Beach, both of which are stocked. When the river runs high, people can occasionally be seen rafting, canoeing and kayaking. Camping is not allowed in the RGVSP.

Currently, the primary limits to the function of the bosque as an interpretive and recreational resource are the jetty jacks and insufficient accessibility. In particular, jetty jacks are major obstacle for hikers, equestrians and bicyclists. The jetty jacks also impede the tasks of maintenance crews, Open Space Law Enforcement, and fire fighters. Because of this fire hazard and current drought conditions, the bosque is often closed during the summer months. The number of access points and their relative accessibility in the context of the Americans With Disabilities Act (ADA) is limited. Only neighborhoods adjacent to the Bridge Boulevard and Central Avenue bridges have sufficient access, and only the paved Paseo del Bosque trail, on the east side of the river, is fully accessible. Collectively, these issues were a key set of concerns mentioned by a number of stakeholders and community members at the public meetings.

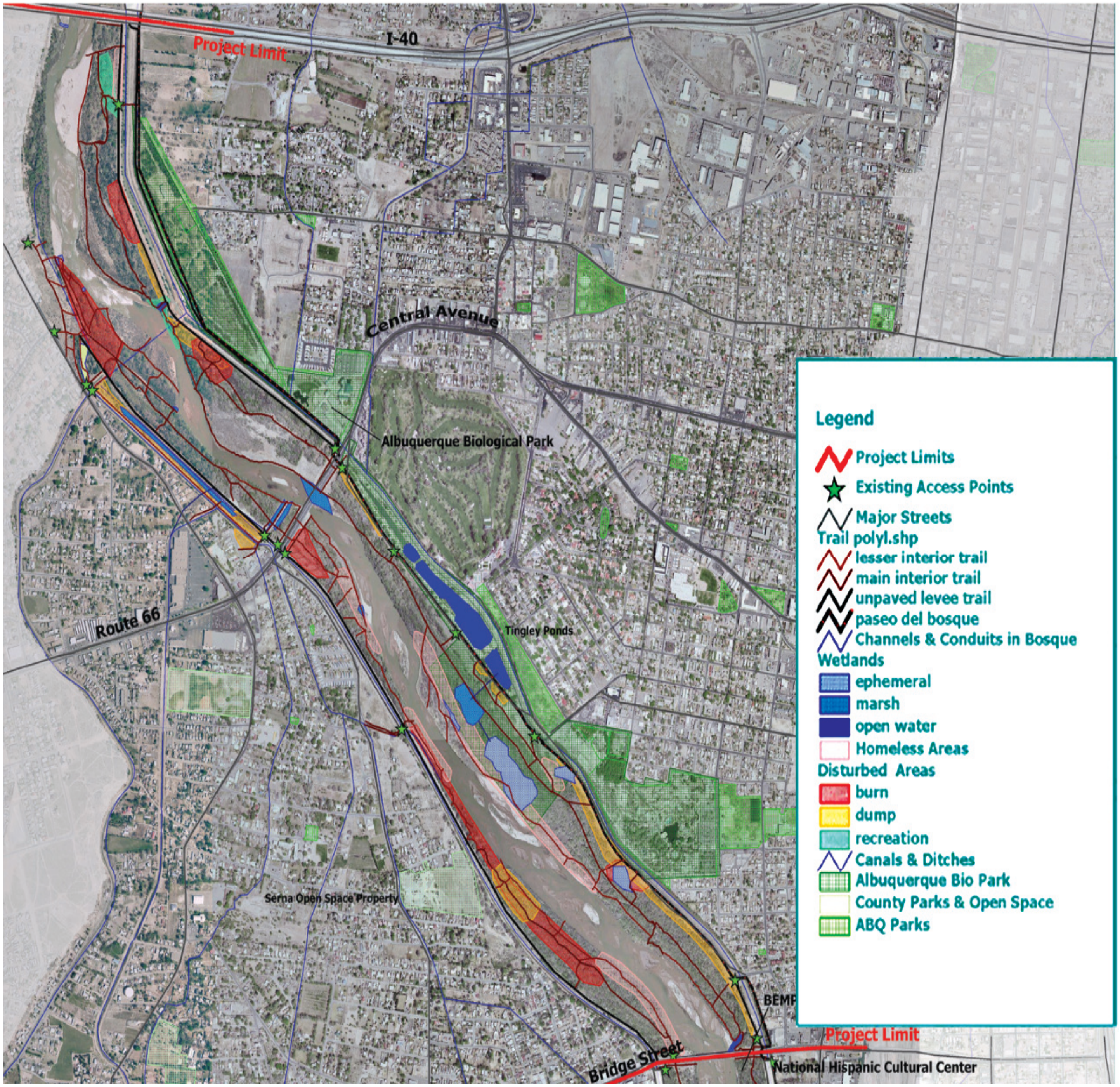


Figure 2.36 Human Use in the Study Area

Interpretation and education are important means of informing the public about the value of a resource. Presently there are only two permanent interpretive displays or signage within the Study Area. The Botanical Garden and the Aquarium have displays that relate to the bosque, and occasionally have guided tours. The bosque near the Biological Park, especially south of Central on the east side, is often used by summer nature camps and other bosque guides and educators. The Bio-Park Project would include interpretive areas along the restored Tingley Ponds and adjacent to the restored wetlands. The Rio Grande Nature Center, two miles north of the Study Area on the east side, has the most extensive interpretive and educational displays on the bosque anywhere in Albuquerque. The Hispanic Cultural Center, which is located just south of the Study Area, is also in the process of developing an interpretive program for the bosque.

2.13 Hazardous, Toxic, and Radiological Waste

A review of the public record and interviews concluded that there are no hazardous, toxic, or radiological waste sites within the Study Area (HTRW). The HTRW Report was drafted to support the Study and is included in the Technical Appendix. A short summary of the report is presented in this section.

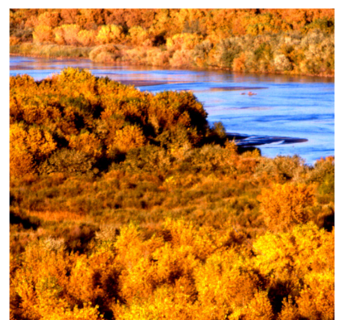
Near the Study Area, there is only one leaking underground storage tank (LUST) site on Central on the west side of the river. The New Mexico Environment Department (NMED) is monitoring this site, and it is believed that the contaminants would attenuate naturally. Beyond the one LUST site, there are no hazardous waste sites in or adjacent to the subject area.

Site visits revealed sediment, solid waste, and construction debris dumped or stockpiled in several locations across the Study Area. There is no evidence to indicate industrial or hazardous wastes present in the Study Area..

2.14 Aesthetics

The current 'aesthetics' of the Study Area include a mostly native, somewhat manicured, park-like bosque with a fair amount of informal public access. Views are fairly open and walking through the bosque one can see, hear and smell many natural parts of the bosque (animals, water, flowers, etc.) that many Albuquerqueans have come to love.

Section 3 Future Conditions Without Project



This chapter explains the likely future conditions within the Study Area if the proposed project were not implemented. This is the 'future-without-action' alternative (also called the 'no-action' alternative.) This chapter contains an analysis of likely environmental effects of the no-action alternative. These future conditions and effects are the basis for comparison with those of the proposed plan.

There are a number of agencies involved in restoration work along the Albuquerque Reach of the Middle Rio Grande including the MRGCD, AOSD, NMISC, Ciudad Soil and Water Conservation District, USBOR, and the MRGESCP to name a few. Some of their work has taken place or is proposed to take place in the Study Area. Much of the work of MRGCD, AOSD and Ciudad has been fuel reduction in the bosque. Much of the work of by the USBOR and NMISC is part of and has been funded by the MRGESCP. Much of this work has been within the river to create habitat for the Rio Grande silvery minnow. This work would continue and effects on environmental and cultural components are discussed below.

Without plan implementation, the bosque in the Study Area would continue to decline, decreasing both in habitat value and as a resource for the greater Albuquerque community. The size and density of non-native vegetation patches, composed of Siberian elm, Russian olive, salt cedar, tree of heaven and white mulberry, are likely to increase as they out-compete the native cottonwoods, willows and other native understory and mid-canopy plants. Native vegetation would not be planted to help increase their population. High flow channels would not be constructed, and therefore a diversity of habitat created in these high flow channels would not occur. Without plan implementation, a mosaic of different vegetation types as described would not occur. Non-native vegetation would continue to overtake the existing native vegetation and create thick patches of fuel for potential fire. Despite the best efforts of the AOSD and MRGCD, devastating fires are likely to increase in number and magnitude. The future bosque is likely to have a very different character than the current bosque (see **Figure 3.1**).

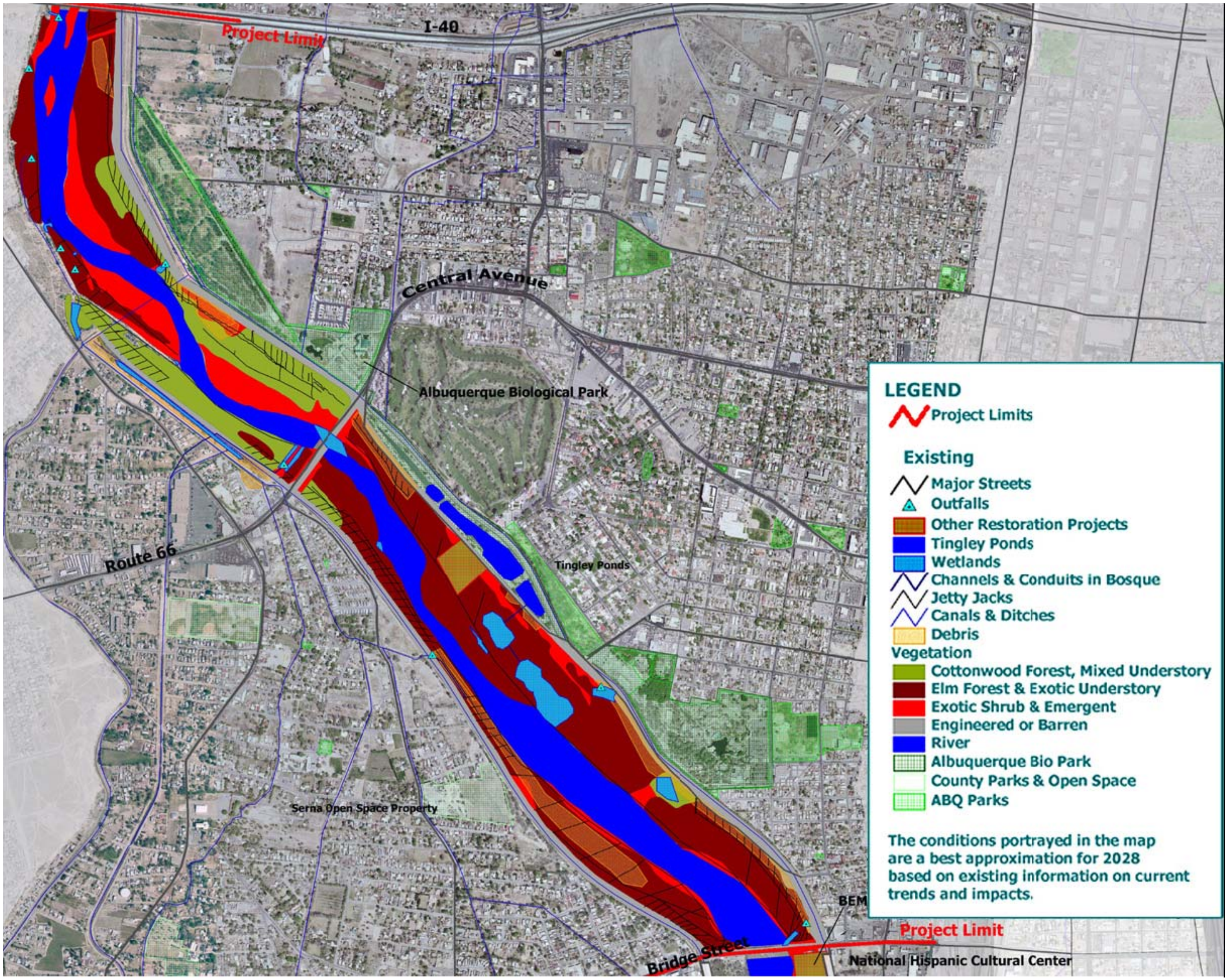


Figure 3.1 Future Without Project Conditions

For the purposes of this section, a 25-year life period is considered for determining the future “without-project” conditions. The following sections describe the anticipated future conditions of specific facts of the resource if the project were not implemented.

3.1 Soils

Soil characteristics, rates of erosion, and sediment deposition patterns would remain mostly unchanged from the existing condition in the absence of plan implementation. Floodplain soils would not be replenished because areas would continue to remain isolated from flows without the proposed restoration features. Initiatives by other agencies, especially maintenance of areas already thinned, would cause some vehicle use in the bosque and potentially affect soils. This use is most likely on an occasional basis and would not cause major changes to the soil makeup.

3.2 Hydrology, Hydraulics and Sediment Continuity Analysis

The geomorphologic and hydrologic processes that historically produced a healthy river system (including the main flow channel and its floodplain working in a mutually beneficial relationship) were described in Section 2.2. The following text from that section is repeated here to summarize the result of these processes prior to major human impacts on the Middle Rio Grande.

> *"…..(the river experienced) periods of stability that allowed riparian vegetation to become established on riverbanks (mostly on the inside of river bends) and islands alternating with periods of instability (e.g., extreme flooding) that provided, by erosion and deposition, new locations for riparian vegetation. A mosaic of cottonwood and willow community types, of varying age classes, size and extent, would be interspersed with more open areas of ponded water, grasslands, marches, and wet meadows. Areas where erosion forces were less active would produce older age class stands of native vegetation (Hanson 1997, Crawford et al. 1993, Leopold 1964)."*

Previous water projects on the Middle Rio Grande have significantly altered the functioning of the hydrologic system. The system is becoming more incised leading to a perched channel and is essentially channelized (Crawford et al. 1993). These trends are likely to continue. An earlier study (USACE 2002) provides some quantitative data on the predicted changes in the Santa Ana reach without any interaction from man. While the reaches are geographically different, the general trends discussed in that report are almost certain to occur in the Albuquerque reach under the "no action" alternative as well. These trends include a resulting channel which is "significantly deeper and narrower", "essentially...elimination of slackwater overbank areas", and a large loss of sediment within the system (USACE 2002).

The previous water projects have altered the timing and duration of peak flows releases so that they may no longer be suitable for germination and establishment of native species (Fenner et al. 1985, Szaro 1989). Still further research has reached the same conclusions, that the consequence of all the previous actions for native riparian vegetation is a drastic reduction in the numbers of sites and opportunities for further recruitment (Howe and Knopf 1991, Milhous et al. 1993).

In addition to the arguments of predicted physical changes presented above, expected changes in water demands in the area would also impact the geomorphology and hydrology of the Study Area. The USBOR has recently published a proposal called "Water 2025: Preventing Crises and Conflict in the West" (USBOR 2003). This document identifies the Middle Rio Grande Valley as an area that has a high likelihood of potential conflict by 2025. These locations are defined as areas where existing supplies are not adequate to meet water demands for people, for farms and for the environment.

In 2005, Mussetter Engineering, Inc. (MEI) was retained by the Corps under the Middle Rio Grande Bosque Restoration Feasibility Study to perform hydraulic modeling using the FLO-2D model. The FLO-2D modeling is intended to provide assessment of overbank flows and storage, as well as hydraulic data to facilitate an analysis of sediment transport conditions and geomorphic processes along the reach, results from which will be used to evaluate various riparian and wetland restoration alternatives. This report summarizes the analysis of the baseline conditions, which is the first phase of the modeling project under this task order. The analysis included (1) development of the hydrologic scenarios, (2) FLO-2D model development, model verification and application, and (3) a baseline channel-stability analysis. The report is entitled, "FLO-2D Model Development, Albuquerque Reach, Rio Grande, NM" by MEI dated January 24, 2006. This analysis was used to verify areas that were determined by HEC-RAS modeling to be lower lying areas (ie: the High Flow Channels or locations for Swales) that could be inundated if they were reconnected to the river. If this project were not implemented, these bosque-river connections would not be made to the level proposed.

With the limiting factors of institutional / jurisdictional controls described in Section 2.2, the seasonal flow patterns and on-going channel maintenance activities are not likely to change in the near future. Considering the increased water demand identified in the Water 2025 report and the geomorphologic trends presented above, there would be little opportunity for natural riparian restoration (regeneration) and wetland creation within the Study Area. In fact, the river system is likely to continue to degrade from a geomorphologic and hydrologic perspective.

3.3 Water Quantity

Water quantity in the Study Area would remain in its current status.

3.4 Water Quality

Water quality in the Study Area would continue to be affected by input of contaminants from storm water sewer outfalls including solid waste, fecal coliforms, nutrients, and organic compounds. Other aspects and characteristics of water quality would remain unchanged from the existing condition without implementation of the proposed project.

3.5 Air Quality

If activities of the proposed action were not to occur, some affects to air quality by other projects and maintenance in the area could still occur. Since the area is within the Rio Grande Valley State Park and co-managed by the City of Albuquerque Open Space Division and MRGCD, their activities to maintain areas thinned for fire prevention are likely to continue. Intermittent use of machinery, mostly in the wintertime, could have minor and temporary effects on air quality.

3.6 Noise

As stated above, maintenance activities by other agencies are still likely to occur if the proposed project did not occur. Noise due to use of heavy equipment in the bosque to maintain thinned could occur during the winter. This would have a temporary increase in noise effect.

3.7 Ecological Resources

The models presented in Section 2.7 suggest that continued isolation of riparian vegetation in the Study Area from fluvial geomorphic processes would eventually result in complete dominance of the plant communities by non-native plant species including salt cedar, Russian olive, Siberian elm, white mulberry, and tree of heaven. Vegetation management techniques such as understory clearing and planting of native species may temporarily reset patches of bosque to more natural structural states, but gradual replacement by non-native species would continue to occur even in treated stands unless monitored and maintained for native habitat. Eventual conversion of the bosque to a non-native-plant-dominated ecosystem uninfluenced by hydrologic processes, with fire as an important disturbance mechanism, would diminish habitat suitability and quality for many native animal species, if maintenance did not occur. As stated above, some maintenance would likely occur. Some areas have received some shrub and tree plantings through other projects. This native vegetation would continue to grow and provide some additional habitat for wildlife.

3.8 Special Status Species

- **Rio Grande Silvery Minnow and Flathead Chub** - Aquatic habitat in the Study Area is directly influenced by stream discharge volumes, patterns and sediment supply. Bank erosivity, and thus direct sediment input from the Study Area and local channel dynamics, is unlikely to change with the "no action" alternative. Other agency initiatives are underway to create potential habitat for the Rio Grande silvery minnow including those of the MRGESCP. MRGESCP projects are constructed to benefit the silvery minnow and the WIFL in order to fulfill the 2003 Biological Opinion (USFWS, 2003). A project completed in the Study Area was constructed by the USBOR to increase potential habitat on the bar (in the river) just south of I-40 on the east side of the river. Some of the NMISC projects under the MRGESCP have been to destabilize bars and islands to provide potential RGSM habitat. Therefore, existing aquatic habitat conditions would change and potentially increase within the river under the "no action" alternative but initiatives to increase habitat between the river and bosque (as proposed in this project) would be minimal.

- **Neotropic Cormorant and Whooping Crane** - Current habitat conditions in the Study Area are unlikely to support Neotropic Cormorant or Whooping Crane. This condition would not change with the "no action" alternative.

- **Common Black-Hawk** - Suitable habitat for Common Black-Hawk would continue to decline in the Study Area as non-native species and novel ecological processes, such as fire, become predominant, and native cottonwood forest diminishes.

- **Black Tern, Yellow-Billed Cuckoo, Southwestern Willow Flycatcher, and Bell's Vireo** - Wetlands and native woody riparian vegetation would continue to decline in the Study Area with the "no action" alternative, further diminishing habitat suitability for these species and contributing to their decline. Again, other agency initiatives (such as those under the MRGESCP) may propose projects to benefit the WIFL in this area.

- **Yuma Myotis and Occult Little Brown Bat** - The "no action" alternative is unlikely to change habitat conditions for either of these bats, as they are not closely associated with particular types of riparian vegetation.

- **Pecos River Muskrat and New Mexico Meadow Jumping Mouse** - Emergent wetland habitat would continue to be negligible in the Study Area with the "no action" alternative. Natural processes that create and maintain wetlands would continue to be absent. This would limit the amount of potentially suitable habitat for both of these species to that currently available. Other agency initiatives may move ahead without the implementation of this project, but none are known of at this time.

3.9 Cultural Resources

In a future without project setting, the primary result to the cultural resources in the Study Area would be further deterioration of the ruins of former diversion channels and remnant bridge structures.

3.10 Socioeconomic Environment And Environmental Justice

Without the Route 66 Project, the existing conditions of neighborhoods adjacent to the bosque are likely to remain comparable to the present situation. As such, the neighborhoods would not benefit from potential improvements in quality of life and possibilities for redevelopment stemming from restoration and additional recreation opportunities. The bosque would be less likely to play a key role in redevelopment of the area and it would have an increasingly lower value as a tourist attraction. Some improvements may be made by local agencies if this project were not implemented.

3.11 Land Use

Increased growth in the Albuquerque Metropolitan Area would be a further burden on the river and the lands along the bosque. Most of the land in the Study Area is part of the Rio Grande Valley State Park, and as a result, would remain otherwise undeveloped. Increased densities and corresponding water demand in adjacent areas could impair the water table further. Residential development south of Central, adjacent to the Study Area, and further development of the Albuquerque Biological Park facilities could increase the number of bosque users. In a "future without project" setting, the lack of restoration and the design of a formal trail system to accommodate these additional users could result in even greater disturbance of the bosque, further accelerating its decline. Based on the current regulatory regime, other problematic land uses such as dumping and wood harvesting should not be a widespread problem. Some of these problems may be addressed by local agencies if the project were not implemented, but not at as large of a scale or as expeditiously.

3.12 Interpretive and Recreational Resources

Without the project, the educational and recreational activities currently enjoyed by the citizens of Albuquerque and visitors would remain roughly as they are. As the bosque in the Study Area becomes increasingly hazardous and unsafe due to increased densities of non-native and dead and down vegetation, however, the quality and time for these activities would be increasingly diminished. The bosque would have to remain closed for longer periods of time because of the fire hazard, and the experience would be further degraded. As noted above, the lack of a clearly defined interpretive trail system could lead to the proliferation of trails and off-trail uses, which would further disturb the bosque and accelerate its decline. Again, some improvements by local agencies or other initiatives may improve this situation, but not to the level that the proposed project entails.

3.13 Hazardous, Toxic, And Radiological Waste

In the absence of the project, and given the current regulatory regime and policing of the bosque, the current hazardous, toxic and radiological waste is unlikely to change significantly. It is anticipated that the contaminants at the LUST site identified in Section 2.13 would attenuate naturally over time, thus improving the groundwater quality in a localized area. It is arguable that there would be further degradation of existing habitat because the debris is not a good substrate for most native plant materials, and over time these areas would become dense non-native patches. In addition, the breakdown of the material could result in pollution of shallow ground water. In some places dumps also impede law enforcement officers and firefighters in their efforts to secure public safety and put out fires in the bosque. Finally, the dump sites, in their present state, would continue to negatively impact potential recreational uses and aesthetic enjoyment of the bosque.

3.14 Aesthetics

Without the project, it can be expected that the Route 66 Project area would continue to deteriorate aesthetically according to both conventional scenic vista and proposed vibrant ecology standards. In addition to failing to mitigate impacts to the aesthetic experience of the bosque, increased cottonwood mortality and increased non-native populations would limit visibility and mobility and likely lead to an increase in the number of unsightly homeless encampments, dumping activities and damaging fires. Without the project, points for viewing the bosque and its natural features and environs would become increasingly limited. Some efforts by local agencies and other initiatives may assist in improving aesthetics, but not to the level and amount that is proposed by this project.

Section 4 Plan Formulation and Evaluation Process

4.1 Formulation Process

4.1.1 The Planning Process

The Corps planning process includes six steps that form a structured approach to problem-solving and provide a rational framework for sound decision-making. These steps include: 1) identifying problems and opportunities, 2) inventorying and forecasting conditions, 3) formulating alternative plans, 4) evaluating alternative plans, 5) comparing alternative plans, and 6) selecting a plan. Problems and opportunities are defined, and then the study objectives that would guide efforts to solve these problems and constraints and achieve the stated opportunities are developed. The second step is to develop an inventory and forecast of critical resources relevant to the problems and opportunities under consideration in the planning area. Developing and comparing alternatives which consist of a system of structural and non structural measures to meet, fully or partially, the identified study planning objectives subject to constraints. This is an iterative process which should lead to selection of a plan that meets the project objectives and meets all Corps policies and guidance.

Following analysis of the existing conditions, the goals and objectives set forth in the scoping letter and the Bosque Restoration Study were re-evaluated to ensure they corresponded to the conditions in the Study Area. Restoration features were then developed to meet the goals and objectives. The overall goal of the project is to restore the ecosystem by creating a dynamic mosaic of vegetation and habitat types in the bosque Study Area. The project goals and objectives listed in Section 1 were converted into a suite of restoration features which would attain the goal or objective over the long term (see **Table 4.1**). A target mosaic was derived in part from a review and simplification of historic data on types of vegetation and cover in the Middle Rio Grande and comparison to the existing mosaic in the bosque. Specific restoration features were identified based on opportunities and constraints identified during the field assessment. The features were grouped into four categories of ecosystem restoration: Removal features, water-related features, bosque features and recreational features. The four types of ecosystem restoration features were then combined in multiple variations to develop 11 solutions for restoration activities in 11 sub-areas within the Study Area. Each of the features and the solutions were evaluated in terms of costs and overall habitat units. Alternatives were then generated through the Incremental Cost Analysis (ICA) process explained below. The Best Buy Plan, described in Section 4.4.2, together with additional cost-effective alternative plans were presented to the Sponsor, and the final Preferred Alternative was selected.

Table 4.1 Project Goals, Objectives and Potential Features

Goal/Objective	Potential Features
Increase number and diversity of native Bosque Patches	1. Remove non-native vegetation 2. Create or restore wetland features 3. Restore native understory in Bosque Patches 4. Restore Shrub Thickets 5. Maintain Fire Breaks
Improve diversity and quality of water-related habitat	1. Create Swales 2. Create Outfall Channel Habitat 3. Create High-Flow Channels
Restore Fluvial Processes	1. Swales 2. Outfall Channel Habitat 3. High-Flow Channels
Increase and extend areas of potential habitat for listed species	1. Wetland Features
Reduce fire hazard	1. Remove non-native vegetation 2. Remove dead, down debris 3. Remove Jetty Jacks 4. Maintain fire breaks

4.1.1.a Problems and Opportunities

The Study Area contains problems and opportunities elucidated in Section 1.6 but are also briefly summarized below:

- Past water operations have drastically changed the historic flood regime of the Rio Grande. There are opportunities to recreate some connections between the bosque and the river without jeopardizing flood control measures.
- There is the opportunity to restore aquatic habitat and aquifer recharge potential.
- The lack of annual flooding has resulted in accumulation of sediment, leaf litter, and dead and down wood in the bosque. There is ample opportunity to remove dead and down wood and create space for native plant colonies to establish.
- Human impact on the bosque in the Study Area has brought further degradation through dumping, accidental fires and numerous informal trails. Multiple opportunities exist to clean up the bosque and develop formal trails with educational interpretive signs.
- Dense stands of non-native vegetation have replaced the mosaic of native woodlands, meadows and wetlands. There is an opportunity to remove non-native vegetation and encourage varieties of native plants to re-establish thereby improving habitat.
- Existing strings of jetty jacks and thickets of non-native vegetation increase the potential for catastrophic fires and present obstacles to fighting fires. The opportunity to correct the situation through removal of non-essential jetty jacks and non-native vegetation should be taken, as it is critical to improving habitat.
- The bosque currently is composed of an unhealthy combination of non-native vegetation and threatened aged native trees which have diminished the habitat for both aquatic and terrestrial life. There is an opportunity to rehabilitate the existing bosque into a dynamic mosaic of patches of native vegetation of varying ages, structure types and species.
- The rehabilitation of the bosque from its current state to a healthier and safer environment presents the opportunity to improve the inherent educational value and lessen the impact of recreational use by limiting the trails through the bosque and involving users in the restoration efforts by employing interpretive signage.

4.1.1.b Planning Considerations/Constraints

In addition to the regulations identified in Section 1.9, the following considerations affected the selection of features:

- **Net Water Depletions** – The New Mexico Office of the State Engineer (OSE) and the New Mexico Interstate Stream Commission (NMISC) have indicated a strong concern that there be "no net depletions" of surface or groundwater as a result of the cumulative impacts of all restoration projects in the reach. The exception to this rule would be the use of allocated water pursuant to senior water rights. This consideration limited the size and type of wetlands that were proposed in the planning process. A depletions analysis of the Preferred Alternative was completed and is further described in Section 6, Foreseeable Effects of the Recommended Plan.

- **Channel Modifications** – Interventions that affect the current configuration of the channel, such as bank Jetty Jack Removal, bank shave-down and excavation to enable overbank flooding are also of concern to MRGCD, Corps, USBOR, OSE and NMISC. Such modifications could affect the delivery of water to downstream areas or result in extensive surface water depletions. This constraint also limited the types of water-related restoration features that were considered in the planning process.

- **96-Hour Detention Rule** – Due to OSE and NMISC regulations, no water from storm water events may be detained longer than 96 hours. This limited the size and type of wetlands at storm water outfalls that could be deliberated on in the planning process.

- **Flow Regulation** – Existing downstream capacity and flood control operations of Cochiti Dam could limit the magnitude of flows in the Study Area. This could limit the type of water-related features that were considered in the planning process.

- **Privately Owned Lands** – Privately held lands in the Study Area were eliminated from consideration for restoration activities. This area, approximately 16 acres, is located in the northwest corner of the Study Area (from the old Atrisco Diversion north to I-40 on the west side of the river) and is currently in litigation to determine the legal titleholders. The area is currently posted by the Westland Development Corporation.

- **Limitation on Interpretive and Recreational Enhancements** – Corps policy limits spending for interpretive and recreational elements to 10 percent of the total project cost. This constraint limited the number and type of interpretive and recreational elements that were considered in the planning process.

- **Total Cost** – Pursuant to the Section 1135, WRDA 1986 authority under which this project is being implemented, the total Federal cost of a project may not exceed $5 million.

- **Ongoing projects** – Coordination with ongoing projects and other agencies with management responsibilities in the bosque is critical to the effectiveness of the project. Plans, resultant construction activities and staging areas for other projects limited some of the restoration measures considered in the planning process. In addition, some of the measures proposed by the Planning Team were planned to complement ongoing efforts including the Bio-Park Project and other restorative activities by AOSD, MRGESCP and Rio Grande Restoration within the Study Area.

4.1.1.c Inventory and Forecasting: Generating a Target Mosaic

As noted above in Section 2, Environmental Setting, the nature of the bosque and the mosaic of habitats or patches have changed dramatically since the 17th Century (see **Figure 4.1**, Pittenger 2003, Scurlock 1998). With changes in land use and settlement, the size and composition of various patches within the bosque have also changed (Scurlock 1998). The existence in recent decades of a continuous bosque forest between the river and the levee appears to be unprecedented. Many bosque researchers and commentators now believe that historically the bosque was a dynamic mosaic of riparian wetlands, channels, woodlands, shrub thickets and periodically wet meadows (Pittenger 2003, Crawford et al. 1993). Frequency of flooding, water table elevation and the type of sediment substrate were and continue to be important determining factors of patch type and structure.

Although all Bosque Patch types contribute to the overall habitat value of the bosque, key types of patches support a larger number of species and individuals, including wetlands and patches with thicker vegetation (Hink and Ohmart 1994, Najmi et al. 2005, Pittenger 2003). The latter would include bosque forest or woodland areas with denser understories and shrub thickets. Hink and Ohmart's survey and subsequent research suggests that the edges of these patches–especially where they meet channels, open meadows or wetlands–are of particular importance for wildlife. Therefore, an overall mosaic that includes both "open" and "dense" patches as well as wet areas is the key to maximizing restoration opportunities. This 'reorganization' of patches of bosque, shrubs, and wetlands can be done within today's confined linear floodplain and still reduce fires and save water while providing a variety of high quality habitat (Najmi et al. 2005).

Because of the importance of the mosaic to the goal of wildlife restoration, it was determined that a target mosaic consisting of various types of Bosque Patches should be a basis for the planning process. The target mosaic needed to be based on accounts or descriptions of the bosque prior to major flood control measures, yet no such accounts exist prior to the 20th Century. Information on the composition of the bosque was recorded beginning in the early 20th Century. Starting in 1918, there are surveys of the vegetation types and communities along the Middle Rio Grande (Pittenger 2003). Aerial photographs were taken in 1935 and subsequently have been interpreted to generate vegetation cover maps. Beginning with the work done by Hink and Ohmart, vegetation in the Middle Rio Grande has been surveyed and classified by community type and structure on a decennial basis. **Table 4.2** summarizes the historic data concerning the overall mosaic for Bernalillo County and the Middle Rio Grande in 1985 (Roelle & Hagenbuck 1995, DeRagon 2002).

Table 4.2 Historic Land Mosaic of the Route 66 Study Area

	1995% in Study Area	1935% in Middle Rio Grande *	1935% in Bernalillo Co Reach **	Reference % *****	Target % ******	Final Target *******
Channel	21	24.7	34	29	21	----
Lake & Pond	0	0.1	1	1	0	----
Wetland ***	2	12.9	8	10	10	10
Riparian Shrub ****	15	39.3	39.9	40	20	25
Scrub-Shrub	23	0	0	0	0	----
Riparian Forest	39	23	17.1	20	20	25
Fire Break or Open Understory					29	40
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

Based on 1997 Classification of 1994 Imagery for the Area Between Existing Levees
* from Roelle & Hagenbuck
** from DeRagon
*** includes all water-related features (e.g., salt grass meadows, swales, high-flow channels, etc.)
**** includes non-native shrub areas
***** calculated by averaging Bernalillo County and Middle Rio Grande percentages
****** reflects (1) no increases in channel or open water areas due to constraints on channel modifications and water retention, and (2) a more equal distribution of riparian shrub and riparian forest areas due to constraint of existing conditions (over half in riparian forest) and the fact that 1935 percentages were probably impacted by ongoing wood harvesting
******* reflects removal of channel acreage and simplification by rounding percent to nearest 5%

The target mosaic was developed with the assumption that most of the key existing habitat would have been removed with the clearing and removal of existing vegetation. Other than river channel, the remaining patch types would be almost entirely open areas in the very early stages of succession, or would be woodland/savannah areas with mature cottonwoods and almost no understory. The key to successful restoration would be the establishment of shrub thickets and water-related features into other open areas and replanting of the native understory in the mature cottonwood areas. This strategy corresponds very nicely with another important strategy, one recognized in the aftermath of the fires in the bosque over the last decade: firebreaks would need to be factored into any revegetation scheme for the bosque. By establishing water-related features, bosque understory and shrub thickets into the cleared bosque, the gaps between revegetated patches would remain except for herbs, forbs and juvenile shrubs and trees. These open gaps would, over time, create an edge with the adjacent denser vegetation areas to provide a firebreak to prevent future catastrophic burns.

As noted above in Section 2, in the past, the riparian ecosystem of the Study Area was much larger and functioned very differently than it does now. Periodic flood events maintained a dynamic bosque with a mosaic of patches diverse in size, age and species composition. With urbanization and the advent of flood control measures, however, flooding is not possible in the Study Area (Pittenger 2003). As a result, the Project Development Team decided to aim for a composition of various vegetation structure types within the reduced extent of the Study Area that approximated the pre-flood control mosaic, similar to that described in the Bosque Landscape Alteration Strategy (Najmi et al 2005).

To derive this target mosaic, water-related features were aggregated, including ponds, wetlands, salt grass meadows, etc., into one category, channel areas into a second category, forested areas into a third and shrubby/successional areas into a fourth. Non-native shrub thickets were not included, since the intent is to replace them with native habitat types. Percentages of vegetation type in the Study Area under existing conditions were also calculated. The approximate mean acreage of all the historic data for each of these vegetation types was then computed, and then the acreage was reduced by the acreage of the river channel. Percentages for all the vegetation types were computed and applied to the total acreage of the Study Area. Due to the interest in maintaining some open areas as firebreaks where they currently exist, the total percentages and areas for bosque forest and shrubby areas were halved to generate the final target percentages and target acreages. Because the existing channel cannot be increased in size, an additional 8% was added to the firebreak or open understory areas.

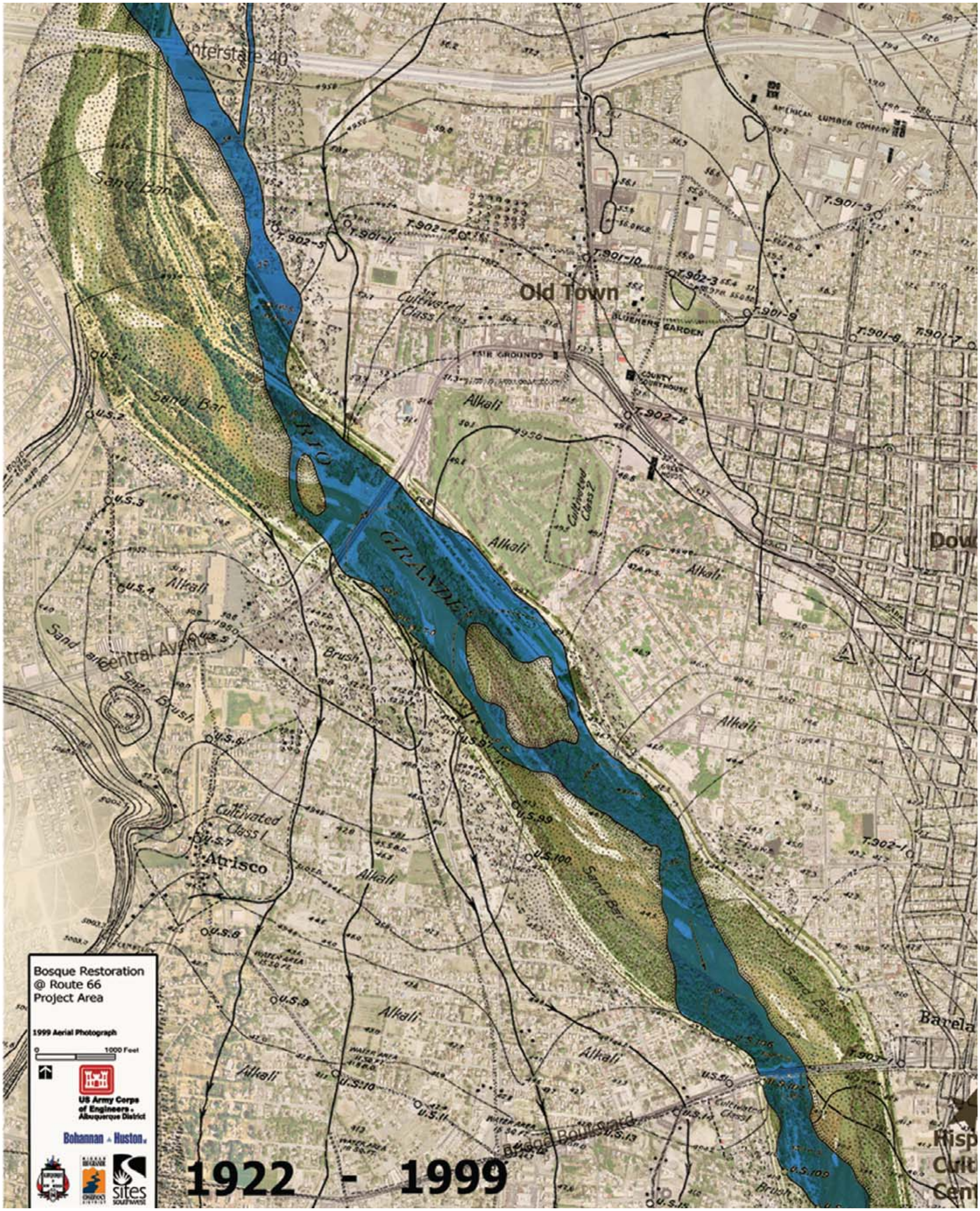


Figure 4.1 Historic Map of the Study Area's Bosque Overlayed on a Contemporary Aerial Photograph

4.2 Formulation of Alternative Plans

For the purposes of this project, the potential restoration features fall into four categories:

- **Removal Features** – including Jetty Jack Removal, Dump and Debris Removal and non-native species and dead wood removal;
- **Water-related Features** – including Outfall Channel Habitat, High-Flow Channels and Swales;
- **Bosque Features** – including the restoration of bosque understory patches and Shrub Thicket patches;
- **Interpretive-Recreational Enhancements** – to include reducing the number of user-made trails by developing a formal trail, access routes for official uses, educational elements about the bosque and restoration efforts.

In order to ensure a fairly fine-grained distribution of restoration features throughout the Study Area, the Study Area was subdivided into a series of eleven "Solution Areas" (**Figure 4.2**). These extend approximately one-half mile along one side of the river and range from 25 to 60 acres in size depending on the width of the bosque in that area. Each was assigned a combination of restoration features. These Solution Areas would then serve as the building blocks from which the various possible environmental restoration plans for the Study Area would be created.

The area south of I-40 on the west side of the Rio Grande is private land and therefore was not included in the plan. Area A on the east side of the river just south of I-40 and was the initial point of ignition for the first fire in the 2003 Montano Complex Burn. Solution Area B includes all the abandoned infrastructure of the Atrisco Diversion header and wasteway on the west side of Rio Grande. Solution Area C includes the Atrisco Siphon intake and the Alameda Canal outfall, a popular fishing area. Solution Area D is just north of Central on the west side of the Rio Grande and includes the early irrigation channel and much of the debris leftover from ditch clean-out work. Solution Area E is also on the east side of the river, adjacent to the Bio-Park. This site was the initial removal site of non-native vegetation for AOSD and one of sites of the Jetty Jack Removal Pilot Project. Solution Area F is south of Central on the west side and includes a remnant of the burned area that has been rehabilitated. Solution Areas G and I are on the east side of the Rio Grande adjacent to Tingley Ponds and include portions of the Bio-Park Project wetlands project. Area H is located on the west side of the river, and is the narrowest Solution Area and includes the Sunset irrigation outfall. Solution Area J is just north of Bridge Boulevard on the west side and is almost entirely a forest, one dominated by elms and Russian olive. Solution Area K is just north of Bridge on the east side and includes the Barelas Storm Drain outfall. Ranges of habitat features were then connected to net habitat units, and costs (Construction, Operation and Maintenance) were calculated.

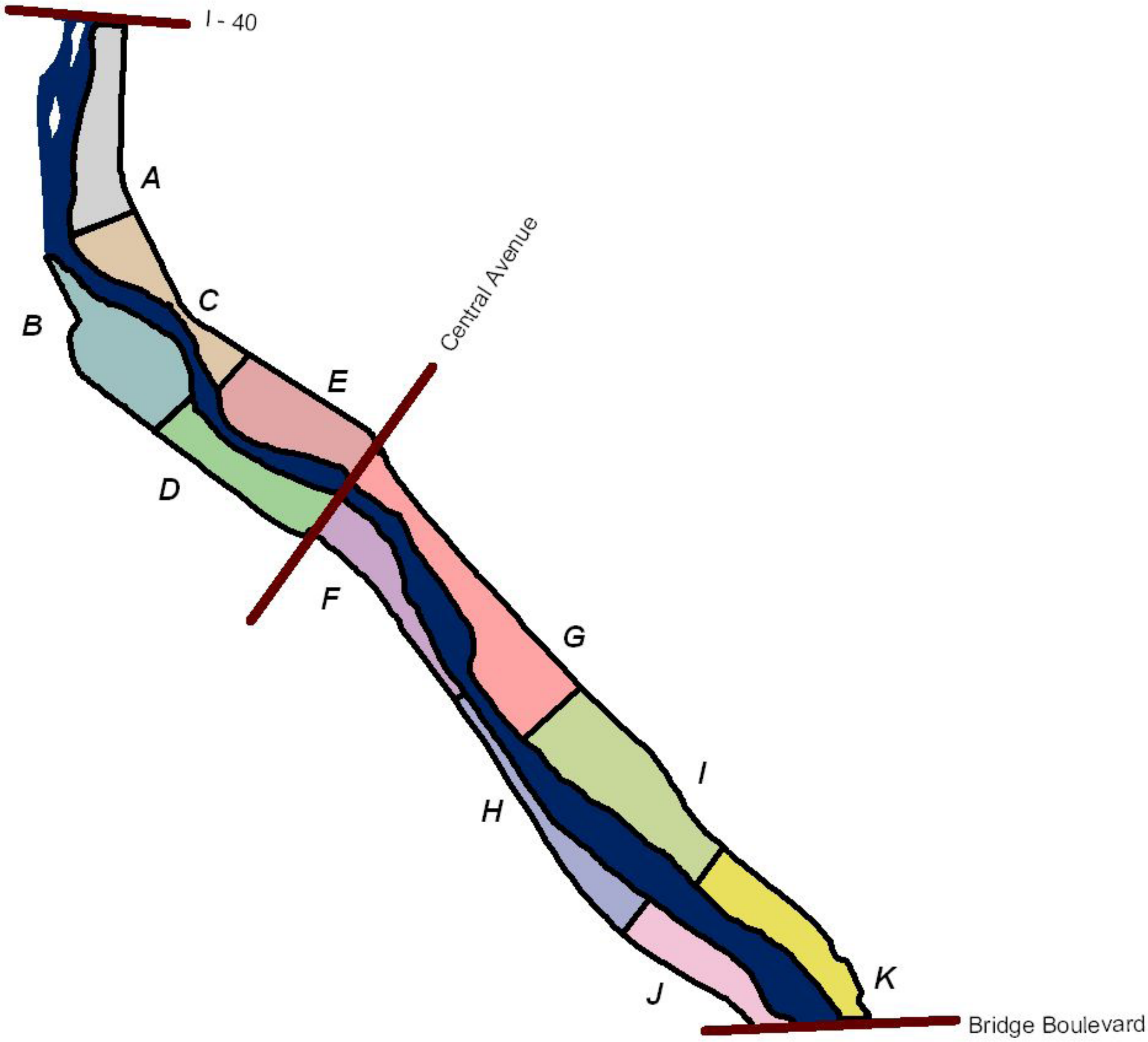


Figure 4.2 Solution Areas within the Study Area

NOTE: Features of all four types are located in each Solution Area; the Solution Area is indicated in parentheses (A, B, C, D, E, F, G, H, I, J or K) in front of the measure in the following sections. (See Section 4.2 for a discussion of Solution Areas.)

4.2.1 Removal Features (Features 1, 2 and 3)

The first step in restoration of the Study Area would be to clear and remove non-native vegetation, dead and down wood, construction debris and non-functional jetty jacks. As of the date of this report, much of the Study Area has been initially cleared of non-native vegetation and dead and down wood by the AOSD. Pursuant to the Bosque Wildfire Project, all non-functional jetty jacks would be removed to facilitate future fire fighting restoration efforts. Over time, the AOSD and Corps as part of the Bosque Wildfire Project, have also been removing debris from the Study Area in conjunction with various stakeholders and private interests. **Figure 4.3** reflects the status of the Removal Features as of Summer 2004. Features **1.1** to **1.10** are Jetty Jack Removal features; features **2.1** to **2.8** are non-native and dead wood removal areas; and features **3.1** to **3.9** are Dump and Debris Removal areas.

4.2.1.a Jetty Jack Removal (Measures 1.0-1.10)

The removal of "non-functional" jetty jacks would assist in the effort to remove non-native vegetation and dump debris by improving access to the affected areas. Removal would also enhance the aesthetic qualities of the bosque and increase safety to potential users.

Jetty jacks, specifically Kellner Jetty Jacks, initially facilitated the creation of a bank line for the low-flow channel by slowing the flow of water and allowing deposition of sediment. Vegetation colonized the newly deposited sediment, further stabilizing the new bank. The various types of jetty jacks, which are described above in greater detail under existing conditions, include bank-line jacks, tie-back jacks and connecting jacks. Earlier types of bank stabilization efforts such as the older post-cable-wire retards from the 1930s are also evident in the Study Area (Berry and Lewis 1997:24, **Figure 4.3**).

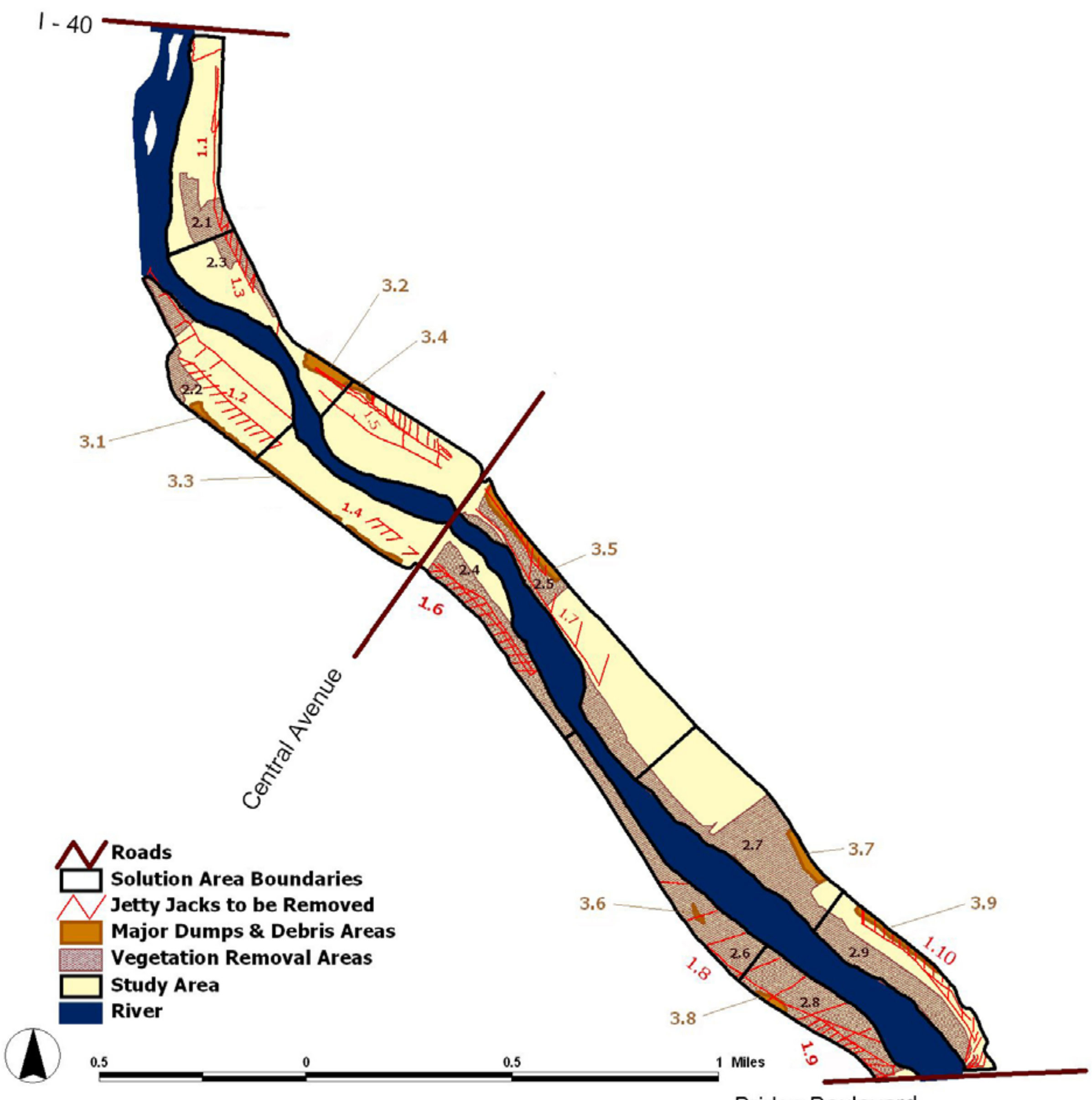


Figure 4.3 Removal Features

The Corps evaluated various methods for mechanical removal of jetty jacks and assessed the subsequent environmental impacts (see USACE 2003). **Figure 4.4** shows a jetty jack being removed at the Corps Los Lunas Project (USACE 2002). Non-functional jetty jacks have been removed as part of Corps' ecosystem restoration projects at Los Lunas, Santa Ana Pueblo, and the Bosque Wildfire Project. In addition, a Jetty Jack Removal pilot project removed jetty jacks in the Study Area on the east side of the river, just north of the Central bridge and south of the Bridge Boulevard bridge near the Hispanic Cultural Center. Additional funds and planning under the Bosque Wildfire Project are targeted for removal of non-functional jetty jacks throughout the Albuquerque reach.

Figure 4.4 Jetty Jack Removal in Los Lunas

Non-functional jetty jacks are shown in red in **Figure 4.3**. They represent approximately 70 percent of the jetty jacks in the Study Area.

For the Jetty Jack Removal feature, the following management measures have been generated for specific locations in the Study Area based on existing conditions:

Feature 1.0 – 1.10: Jetty Jack Removal	
1.0	**No Action**
1.1	**1-40 South**
1.2	**Atrisco Diversion**
1.3	**Alameda Ditch Outfall**
1.4	**Central NW**
1.5	**Central NE**
1.6	**Central SW**
1.7	**Tingley #1**
1.8	**Sunset**
1.9	**Bridge NW**
1.10	**Bridge NE**

No Action - 1.0

No jetty jacks would be removed in the Study Area.

(A) I-40 South Jetty Jack Removal - 1.1

South of I-40 on the east side of the Rio Grande, there are roughly 192 non-functional jetty jacks that may be removed. Some of the existing jack lines have been cut by AOSD to facilitate burn restoration and removal of non-native vegetation and dead and down wood. Additional jacks in the riverbank-line would remain, and a series of the earlier type of bank stabilization measures would also remain as-is.

(B) Atrisco Diversion Jetty Jack Removal - 1.2

In the vicinity of the old Atrisco diversion on the west side of the Rio Grande, there are 308 non-functional jetty jacks that can be removed. Many of the jacks are in place to armor the diversion channel and wasteway, which no longer functions. Some of the existing jack lines have been cut by AOSD to facilitate burn restoration and the removal of non-native vegetation and dead and down wood in the area, as well as the creation of the larger swales just east of the sluice gate. The jacks in the riverbank-line would remain in place.

(C) Alameda Ditch Outfall Jetty Jack Removal - 1.3

In the vicinity of the Alameda ditch outfall on the east side of the Rio Grande, approximately 153 non-functional jetty jacks can be removed. Some of the existing jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and down wood. Most of the jacks that armor the outfall area, which continues to function, as well as the jacks in the riverbank-line would remain in place.

(D) Central NW Jetty Jack Removal - 1.4

In the vicinity of the Central Avenue bridge to the north on the west side of the Rio Grande, some of the jacks appear to have been removed already. Some of the existing jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and down wood. Approximately 87 non-functional jetty jacks remain and can be removed. The jacks in the riverbank-line would remain in place.

(E) Central NE Jetty Jack Removal - 1.5

In the vicinity of the Central Avenue bridge to the north on the east side of the Rio Grande, some of the jacks have already been removed as part of the Jetty Jack Removal Pilot Project (USACE 2003). Some of the remaining jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and downed wood. Approximately 278 non-functional jetty jacks can be removed. The jacks in the riverbank-line would remain in place.

(F) Central SW Jetty Jack Removal - 1.6

In the vicinity of the Central bridge to the south on the west side of the Rio Grande, some of the jacks appear to have been already removed during the burn restoration. Some of the remaining jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and down wood. Approximately 287 non-functional jetty jacks can be removed. The jacks in the riverbank-line would remain in place.

(G) Tingley #1 Jetty Jack Removal - 1.7

In the vicinity of the Central bridge to the south on the east side of the Rio Grande, some of the jacks were already removed as part of the Bio-Park Project and the Rio Grande Restoration community project. Some of the remaining jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and down wood. Approximately 254 non-functional jetty jacks can be removed. The jacks in the riverbank-line would remain in place.

(H) Sunset Jetty Jack Removal - 1.8

On the west side of the Rio Grande near the Sunset irrigation outfall, most of the existing jacks would not be removed because of the narrowness of the bosque in this area. The jacks in the riverbank-line would remain in place. As in other areas, some of the jack lines have been cut by AOSD to facilitate the removal of non-native vegetation and dead and down wood. Approximately 80 non-functional jetty jacks can be removed.

(J) Bridge NW Jetty Jack Removal - 1.9

The area on the west side of the Rio Grande just north of Bridge Boulevard has the largest number of jacks to be removed, 355. As in other areas, some of the jack lines have been cut already by AOSD to facilitate the removal of non-native vegetation and dead and down wood. The jacks in the riverbank-line in the areas would remain in place.

(K) Bridge NE Jetty Jack Removal - 1.10

On the east side of the Rio Grande just north of Bridge Boulevard, there are 286 non-functional jetty jacks that can be removed. As in other areas, some of the jack lines have been cut already by AOSD to facilitate the removal of non-native vegetation and dead and down wood. The jacks in the riverbank-line would remain in place.

4.2.1.b Clearing and Removal of Non-native Vegetation (Measures 2.0-2.9)

Non-native plant removal would facilitate restoration efforts by removing the chief competition to native trees, shrubs, forbs and grasses. Non-native plant removal would also reduce the fire hazard, enhance aesthetic and recreational aspects of the bosque and improve security.

Figure 4.5 Non-Native Fuel Load Removal Activities by AOSD

Much of the non-native vegetation has already been removed from the Study Area. In the aftermath of the bosque fires that occurred in the summer of 2003, AOSD has accelerated its ongoing efforts to remove major fuel loads, including non-native trees and dead and down wood (**Figure 4.5**).

Only isolated areas remain where major clearing and removal of non-native vegetation would be necessary. In other areas, however, isolated patches exist that still require attention; for example, on the west side between Central Avenue and Bridge Boulevard are extensive areas where non-natives have been thinned but not eliminated.

As a result of the clearing, it would appear that most of the thick habitat in the Study Area has been removed. The impact of the clearing process, however, is still being evaluated. All subsequent removal efforts, including the Bosque Wildfire Project, would need to be tied directly to replanting efforts.

In many areas, continued maintenance and repeated treatment for stump sprouting and removal of juvenile volunteer non-natives would be necessary. This is provided for under the operations and maintenance portion of the project.

For the Non-native Vegetation Removal feature, the following management measures have been generated for specific locations in the Study Area based on existing conditions in Summer 2004:

Feature 2.0 – 2.8: Non-Native Vegetation Removal	
2.0	**No Action**
2.1	**1-40 South**
2.2	**Atrisco Diversion**
2.3	**Alameda Ditch Outfall**
2.4	**Central SW**
2.5	**Tingley #1**
2.6	**Sunset**
2.7	**Tingley #2**
2.8	**Bridge NW**
2.9	**Bridge NE**

No Action - 2.0

Non-native vegetation would not be removed.

(A) I-40 South Non-native Vegetation Removal - 2.1

South of I-40 on the east side of the Rio Grande, most of the area has been cleared in the aftermath of the bosque fire of the summer of 2003. There are roughly 9.3 acres of channel and early succession shrub patches that would need additional clearing and removal of non-native species. Also, the whole area would need to be retreated for non-native plants.

(B) Atrisco Diversion Non-native Vegetation Removal - 2.2

In the vicinity of the old Atrisco diversion on the west side of the Rio Grande, there are two patches of mixed non-native and native vegetation, for a total of 7 acres. The first patch is at the header next to the river, and the second is in the area between the sluice gate and the beginning of the Atrisco ditch. Also the whole area would need to be retreated for non-native plants.

(C) Alameda Ditch Outfall Vegetation Removal - 2.3

In the vicinity of the Alameda ditch outfall on the east side of the Rio Grande, most of the area has been thinned, but a small patch (3 acres) remains and the whole area would need to be retreated for non-native plants.

(F) Central SW Non-native Vegetation Removal - 2.4

In the vicinity of the Central Avenue bridge to the south on the west side of the Rio Grande, much of the area has been cleared, although it appears many non-native trees were left behind to soften the impact of the clearing process. Over time these would be removed, as would the sprouts from the cut trees and the area where cottonwoods were pole-planted in the aftermath of the July 2003 fire. In total, there are approximately 25 acres of vegetation requiring removal. Additionally, the whole area would need to be retreated for management of non-native plants.

(G) Tingley #1 Non-native Vegetation Removal - 2.5

In the vicinity of the Central Avenue bridge to the south on the east side of the Rio Grande, some of the non-native plants have been already removed as part of the Bio-Park Project and the Rio Grande Restoration community project. In total there are approximately 24.8 acres of vegetation to remove. Also, the whole area would need to be periodically retreated to manage non-native plants.

(H) Sunset Non-native Vegetation Removal - 2.6

On the west side of the Rio Grande near the Sunset irrigation outfall, much of the area has been cleared, although it appears many non-native trees were left behind to soften the impact of the clearing process. Over time these would need to be removed, as would the sprouts from the cut trees. In total, there are approximately 25 acres of vegetation in this area requiring removal. Also, the whole area would need to be retreated for non-native plants.

(I) Tingley #2 Non-native Vegetation Removal - 2.7

In the vicinity of the main Tingley pond on the east side of the Rio Grande, some of the non-native plants have been removed as part of the Bio-Park Project and the Rio Grande Restoration community project. However, there are approximately 33 acres of vegetation requiring removal in this area. Also the whole area would need to be retreated for management of non-native plants.

(J) Bridge NW Non-native Vegetation Removal - 2.8

On the west side of the Rio Grande just north of Bridge Boulevard, much of the area has been cleared, although it appears many non-native trees were left behind to soften the impact of the clearing process. Over time these would need to be removed, as would sprouts from the cut trees. In total there are approximately 27 acres of vegetation in need of removal. Also the whole area would need to be retreated for controlling non-native plants.

(K) Bridge NE Non-native Vegetation Removal - 2.9

On the east side of the Rio Grande just north of Bridge Boulevard, much of the area close to the levee has been cleared. Over time the area closer to the river would need to have the non-native vegetation removed; totaling approximately 26.9 acres.

4.2.1.c Clearing and Removal of Dumps and Debris (Measures 3.0-3.9)

Figure 4.6 Major Dump Site in the Study Area

Clearing and removal of dumps and debris would enhance the restoration process by eliminating a major disturbance to the bosque: non-native plants tend to colonize disturbed soils created by dumping. Removal of the debris would also enhance public safety, as well as aesthetic and recreational aspects of the bosque. Most of the dumped debris is construction demolition waste that was illicitly dumped on the surface (see **Figure 4.6**).

To calculate the total amount of fill to be removed, the surficial area was measured using an aerial photograph and then verified in the field; the area was then multiplied by an assumed depth of three feet.

Over time, AOSD has been working with community organizations and private businesses to clean up the dumps along the east side of the river south of Central. To date, these activities have removed most of the dumped debris from Alcalde Place north to just beyond the Rio Grande Restoration Demonstration Project Area.

In most cases, dumpsites may need to be excavated in order to remove the debris. Such excavation may result in depressed areas closer to the water table that can be utilized for swales. Every attempt should be made to find on-site uses for the debris such as base material for trails and parking areas.

For the Dump and Debris Removal feature, the following management measures have been generated for specific locations in the Study Area based on existing conditions as of Summer 2004:

Feature 3.0 – 3.9: Dump and Debris Removal	
3.0	**No Action**
3.1	**Atrisco Diversion**
3.2	**Alameda Ditch Outfall**
3.3	**Central NW**
3.4	**Central NE**
3.5	**Tingley**
3.6	**Sunset**
3.7	**Tingley #2**
3.8	**Bridge NW**
3.9	**Bridge NE**

No Action - 3.0

Debris and dump material would not be removed.

(B) Atrisco Diversion Dump and Debris Removal - 3.1

In the vicinity of the old Atrisco diversion on the west side of the Rio Grande, there are a series of debris piles. A total 47,000 cubic yards are proposed for removal from this area.

(C) Alameda Ditch Outfall Dump and Debris Removal - 3.2

In the vicinity of the Alameda ditch outfall on the east side of the Rio Grande, there is an extensive construction debris area. Approximately 110,000 cubic yards are proposed for removal from this area.

(D) Central NW Dump and Debris Removal - 3.3

In the vicinity of the Central bridge to the north on the west side of the Rio Grande, there are a series of debris piles. This has been used as a stockpile area by the MRGCD. Approximately 28,000 cubic yards are proposed for removal from this area.

(E) Central NE Dump and Debris Removal - 3.4

In the vicinity of the Central bridge to the north on the east side of the Rio Grande, there is an extensive construction debris area. The AOSD has been working on debris removal in this area. However approximately 24,000 cubic yards still remain in this area and should be removed.

(G) Tingley #1 Dump and Debris Removal - 3.5

In the vicinity of the Central bridge to the south on the east side of the Rio Grande, there is an extensive area of construction debris. Approximately 154,000 cubic yards are proposed for removal from this area.

(H) Sunset Dump and Debris Removal - 3.6

On the west side of the Rio Grande near the Sunset irrigation outfall, there is a series of small trash dumps. Approximately 8,000 cubic yards are proposed for removal from this area.

(I) Tingley #2 Dump and Debris Removal - 3.7

In the vicinity of the main Tingley pond on the east side of the Rio Grande there is an extensive construction debris area. Approximately 86,000 cubic yards are proposed for removal from this area.

(J) Bridge NW Dump and Debris Removal - 3.8

On the west side of the Rio Grande just north of Bridge Boulevard, there is a series of small trash dumps and a small construction debris area. Approximately 36,000 cubic yards are proposed for removal from this area.

(K) Bridge NE Dump and Debris Removal - 3.9

On the east side of the Rio Grande just north of Bridge Boulevard, there is an extensive construction debris area. There is also a significant amount of trash around the Barelas outfall. Approximately 82,000 cubic yards are proposed for removal from this area.

4.2.2 Water-Related Features (Features 4, 5, and 6)

Establishment of healthy stands of cottonwoods and other native species requires water, preferably in the form of flooding for brief periods of time, until the roots are mature enough to reach essential fluids and nutrients on their own. The purposes of the water-related features described in this section are to attempt to mimic natural periods of inundation in specific areas under certain conditions. This would create a hospitable environment for propagation of native vegetation and produce wetted areas that would increase the diversity of habitat types.

Strategies that were considered for these modifications include features 4 (Outfall Channel Habitat), 5 (High-Flow Channels), and 6 (Swales), all of which are located in the bosque or overbank areas as described below.

Due to the complex legal considerations, including water rights and the potential requirements for sophisticated modeling that may be required for in-channel modifications, it was decided not to pursue any in-channel hydraulic modifications, such as bank shave-down areas or grade reduction facilities, for the Route 66 Project.

It is also important to note that: 1) none of the proposed features would divert any water from the low-flow channel of the Rio Grande, and 2) none of these features or corresponding measures would negatively affect flood control within this reach of the Rio Grande.

The location and design of the water-related features were determined according to site-specific conditions. Variables assessed to make this determination included: depth to groundwater, presence and density of non-native vegetation, existing wetted areas, and presence of storm water or irrigation outfalls or other sources of intermittent water. The various types of water-related features are shown in **Figure 4.7**. Features **4.1 to 4.5** are Outfall Channel Habitat, features **5.1 to 5.6** are High-Flow Channels, and features **6.1 to 6.10** are Swales.

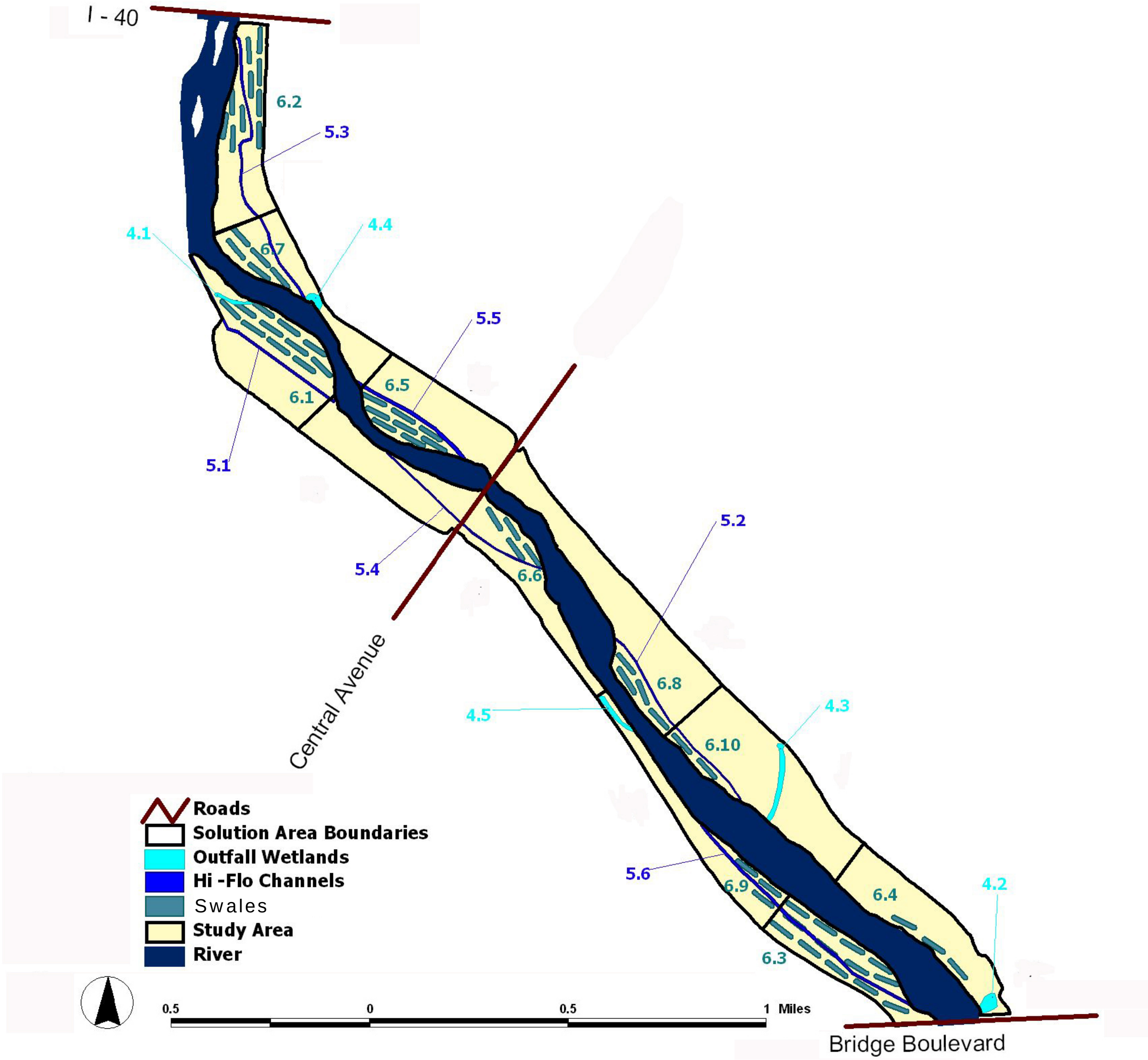


Figure 4.7 Water Related Features

4.2.2.a Outfall Channel Habitat (Measures 4.0-4.5)

Currently, Albuquerque's storm water management system in areas adjacent to the Study Area is designed to convey storm water runoff directly to the river. In most locations, this runoff water enters the bosque prior to joining with the river. Water from municipal storm water outfalls and irrigation return flows generally is of a lower quality than the receiving river water (Riley 1998). The water entering the bosque from the local storm drains or irrigation return outfalls is no exception. Storm water systems drain developed areas and contain high levels of automotive pollutants, while irrigation return flows contain agricultural contaminants (e.g., fertilizers and pesticides). Additional problems with these storm water systems include the typically high velocities associated with their discharge (and therefore higher erosion potential) and the large amount of trash deposited in the vicinity of the outfalls. Restructuring of the channel where the outfall waters exit would help correct some of these issues.

Some simple modifications to the existing outfalls could provide several benefits. The conceptual idea is to connect the outfall through the bosque and to the river, providing wetland and/or moist soil habitat along the way. Each area may be designed differently depending on the outfall size. The idea was modeled after a wetland concept constructed at the Osage / La Media storm drain outfall at the northwest corner of Central and the River (**Figure 4.8**).

Figure 4.8 Osage/La Media Storm Drain Outfall

The general concept is to divert the low flows from the outfall into a reconstructed channel. It is commonly accepted that the majority of the pollutants and trash from these systems is contained in the 'first flush,' that is, the storm water associated with the first 0.25 inches of runoff. The conceptual design includes a sediment pond to collect the bulk of the sediment and pollutants exiting the system during these low flows and a series of shelves within the channel to help address the issues discussed above. The channel would be planted with wetland plants to promote biological activity. Screening devices, either directly on the outlet of the pipes, or a 'dam' within the sedimentation pond, could be designed to remove the trash and help the sediment drop out. The configuration presented in the figure also allows for energy dissipation associated with higher flows. Extremely large flows would quickly run through the channel habitat system. Some erosion protection could be included on a site-specific basis, if needed for the existing flow paths. These measures would also serve to replicate some of the well-known benefits of historical wetlands by removing the contaminants through both biological and hydraulic means (settling) and providing diverse habitat. The channel would also function as backwater habitat. When flows are lower, the 'shelf' adjacent to the river would have water in it. As flows increase, water would move from the river back up in to the channel and also create wet habitat. Additional information on the conceptual designs is included in the Technical Appendix Section 4.

For the Outfall Habitat feature, the following management measures have been generated for specific locations in the Study Area:

Feature 4.0 – 4.5: Outfall Habitat	
4.0	No Action
4.1	Atrisco West Storm Drain
4.2	Barelas Area Storm Drain
4.3	Alcalde Area Storm Drain
4.4	Atrisco Irrigation Return Flow Outfall
4.5	Sunset Irrigation Return Flow

No Action - 4.0

No Outfall Channel Habitat would be constructed.

(B) Atrisco West Storm Drain Outfall Channel - 4.1

On the west side of the Rio Grande, near Atrisco Drive and 49th Street, there are two storm drain outfalls in close proximity. Outflows from these two systems could be combined into one channel area. This Outfall Channel could be constructed to produce approximately 2.05 acres of habitat.

(K) Barelas Area Storm Drain Outflow Channel - 4.2

North of Bridge Boulevard on the east side of the river is the Barelas storm drain outfall. The conceptual design for this site anticipates the production of approximately 0.40 acres of habitat.

(I) Alcalde Area Storm Drain Outflow Channel - 4.3

On the east side of the Rio Grande, south of Central Avenue, is the Alcalde storm drain outfall. The conceptual design for this site is allows for the production of approximately 1.80 acres of habitat.

(C) Atrisco Irrigation Return Flow Outfall Channel - 4.4

On the east side of the river, north of Central Avenue, the MRGCD has a facility that can divert water from the adjacent canal back to the Rio Grande. Due to the close proximity of the existing facilities to the Rio Grande, there is limited potential to provide additional habitat. The conceptual design includes decreasing the steepness of the side slope of the existing outfall area, which would provide a greater diversity of habitat for both plants and animals. This would involve re-grading the existing outfall area. The modifications for this site would produce approximately 0.33 acres of habitat.

(H) Sunset Irrigation Return Flow Channel - 4.5

On the west side of the Rio Grande, south of Central Avenue, the Atrisco lateral irrigation return flow enters the bosque. This location is very near Sunset Drive and is called the Sunset Irrigation Return Flow Channel. Developing a channel in this area could be accomplished more easily compared to other sites due to the existing channel. The design for this site, as it is conceived, would produce approximately 1.00 acre of habitat.

4.2.2.b High-Flow Channels (Measures 5.0 - 5.6)

Under historic flood flow regimes, High-Flow Channels were once an integral part of the river form and function. Evidence of former channels is present in many locations within the Study Area. The old Atrisco diversion header and wasteway currently functions as a High-Flow Channel (see **Figure 4.9**). The objective of this measure is to re-establish the connections between the river and the bosque by creating a situation in which side channels would become inundated at flows between 2,500 – 3,500 cfs. Actions necessary for this feature

Figure 4.9 Atrisco Diversion Header and Waterway Flooded in Spring 2005

typically include dredging the sediment out of the upstream and downstream portions of the remnant High-Flow Channels in order to re-establish the bosque-river connection, clearing out debris and non-native plants and revegetating with native plants to increase the habitat quality within the bosque. High-Flow Channels would deliver much-needed water to bosque vegetation and increase potential water-based habitats for animals.

Figure 4.10, Schematic Design for High-Flow Channel, provides a conceptual cross-section design of a typical High-Flow Channel used in this DPR/EA. The figure also provides some generic information about the revegetation plan for these measures. **Figure 4.7** shows the location of the various High-Flow Channels. Additional information on High-Flow Channels and a conceptual design are contained in Section 4 in the Technical Appendix. Appropriate sediment removal regimes, crossings where necessary for fire and restricted access issues would need to be determined during design development.

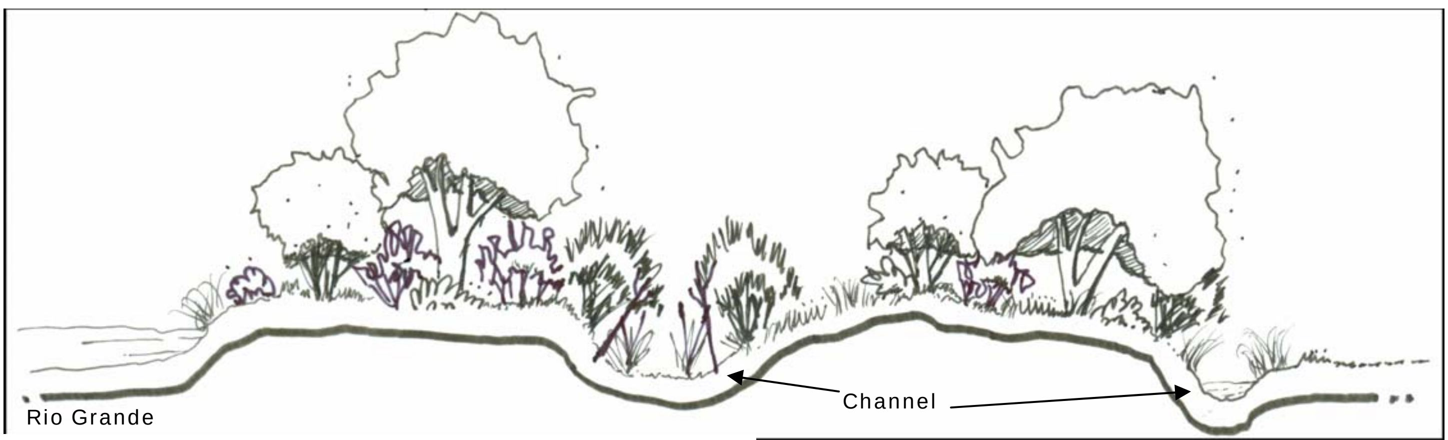


Figure 4.10 Schematic Design for High-Flow Channels

For the High-Flow Channel feature, the following management measures have been generated for specific locations in the Study Area; the Solution Areas appear in parentheses in front of the measures:

Feature 5.0 – 5.6: High Flow Channels	
5.0	No Action
5.1	Atrisco Diversion
5.2	Tingley River Bar
5.3	I-40 South
5.4	Central NW
5.5	Central NE
5.6	Sunset

No Action - 5.0

No High-Flow Channels would be constructed.

(B) Atrisco Diversion Channel - 5.1

On the west side of the Rio Grande, north of Central Avenue, is the location of a former irrigation diversion canal. The canal is still evident but would require dredging to establish the connection to the river and allow water to enter the channels at high flows. Periodic dredging may be necessary throughout the life of the project. There are unique educational and interpretive opportunities at this site. This measure, if implemented, would result in a High-Flow Channel approximately 2,830 feet long and 30 feet wide, producing approximately 3.7 acres of habitat.

(G) Tingley River bar Channel - 5.2

On the east side of the Rio Grande, south of Central Avenue, a river bar has formed along the east bank. A remnant side channel, which only flows during high-flow conditions, runs between the riverbank and the river bar. This area could be modified as described above to provide increased habitat. This measure would result in a High-Flow Channel approximately 2,500 feet long and 15 feet wide, if implemented as the described in the conceptual design, contributing approximately 0.9 acres of habitat.

(A) I-40 South - 5.3

On the east side of the Rio Grande, just south of I-40, a wide segment of bosque has great potential for high quality habitat as a High-Flow Channel. This segment stretches from the I-40 bridge south for approximately one-half mile and includes a large river bar through which a side channel runs. The Project Development Team selected this location as a potential preserve in which user-made trails would be reclaimed as part of the revegetation effort. A High-Flow Channel approximately 3,960 feet long and 25 feet wide would result from this measure. Approximately 2.3 acres of habitat would be produced.

(D) Central NW Channel - 5.4

On the west side of the Rio Grande, near Central Avenue, a remnant channel exists. This channel actually begins north of Central Avenue and extends under the bridge, returning to the river downstream. Approximately 0.9 acres of habitat could be produced from a High-Flow Channel approximately 2,650 feet long and 15 feet wide as described in the conceptual design of this measure.

(E) Central NE Channel - 5.5

On the east side of the Rio Grande, just north of Central Avenue, another opportunity to enhance an existing remnant channel exists. This measure, as conceived in the design, would result in a High-Flow Channel approximately 1,780 feet long and 40 feet wide. This would produce approximately 1.6 acres of habitat. Since the inception of this Study, the feature was constructed by the NMISC under the MRGESCP.

(H) Sunset Channel - 5.6

The final area selected for improvement as a High-Flow Channel lies on the west side of the Rio Grande, just north of Bridge Boulevard. This measure would result in a High-Flow Channel approximately 3,720 feet long and 30 feet wide, contributing approximately 2.6 acres of habitat if the conceptual design is implemented.

4.2.2.c Swales (Measures 6.0 - 6.10)

The Swale feature entails optimizing the depressions created by removal of non-native vegetation, dumped debris and jetty jacks to provide microenvironments in which contain native plants can thrive due to the decreased distance to the water table and moist soils. In certain areas of the bosque, the depth-to-water table is minimal and even slight excavations expose water. Sample plots have illustrated that standing water can occur when the non-native phreatophytes are removed. These excavated areas could be planted with riparian shrub, wetland or mesophytic plants. Depending upon the location, there could be a series of Swales that become progressively drier with increasing distance from the river or water table. Once established, native plants could thrive in these depressions. The established Swales at the Zoo Burn area, the Atrisco Diversion area, and the Brown Burn are good examples of this strategy (**Figure 4.11**). In addition, restoration efforts at other locations have produced water budget savings as a result of the removal of non-native phreatophytes. This feature would create both wet meadow and shrub habitat.

Figure 4.11 Swale at the Brown Burn, South of the Study Area

Figure 4.12, Schematic Design for a Swale, is a conceptual cross-section of a typical Swale designed for this DPR/EA. The figure also provides some generic information about the revegetation plan for these measures. A series of depressions, approximately a half acre in size, would be created within a 5 to 10 acre area. The number of depressions within each Swale would be determined by site-specific conditions. **Figure 4.7** provides an overall project site map showing the location of the various Swale areas. Additional information and a conceptual design for these features can be found in the Technical Appendix Section 4.

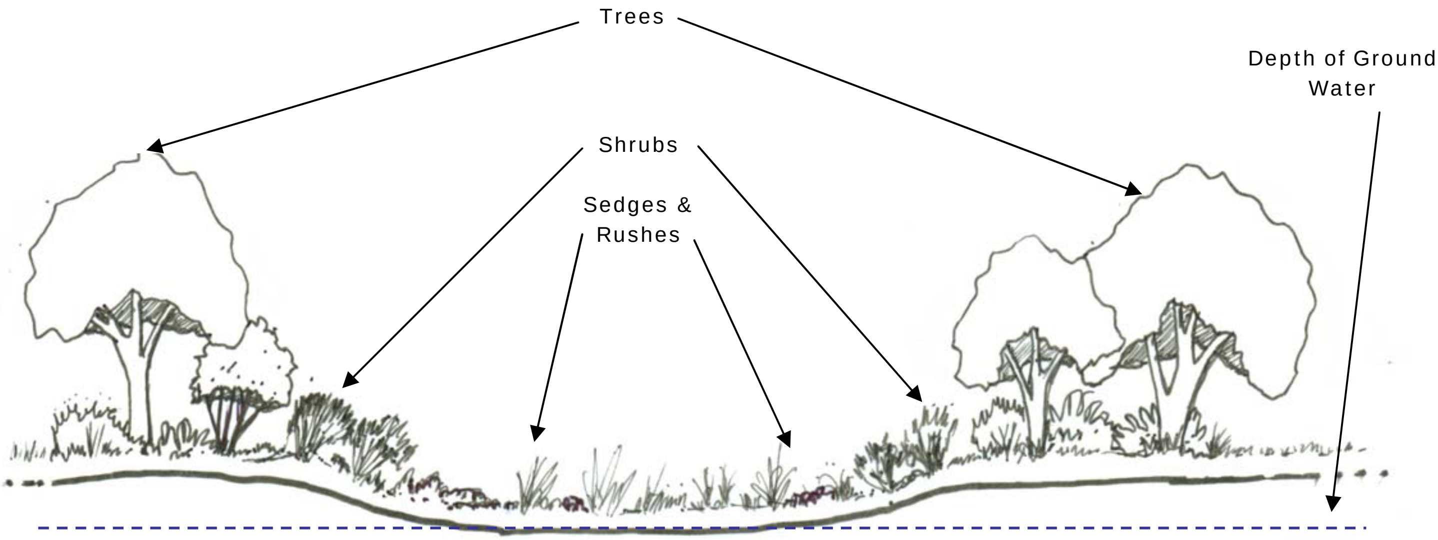


Figure 4.12 Schematic Design for a Swale

The following management measures have been generated for the Swale features for specific locations in the Study Area:

Feature 6.0 – 6.10: Swales	
6.0	No Action
6.1	Atrisco Area
6.2	I-40 South
6.3	Bridge NW
6.4	Bridge NE
6.5	Central NE
6.6	Central SW
6.7	Alameda Ditch Outfall
6.8	Tingley #1
6.9	Sunset
6.10	Tingley #2

No Action - 6.0

No Swales would be constructed.

(B) Atrisco Area Swale - 6.1

On the west side of the Rio Grande, north of Central Avenue, an area has been identified for several Swales. The area also lies on the river side of the proposed High-Flow Channel in this area, so these measures could be designed to work in combination to provide the maximum habitat value. The current concept for this area would provide 5.5 acres of habitat.

(A) I-40 South Swale- 6.2

On the east side of the Rio Grande, just south of I-40, a location for Swales has been identified. These would become part of the North Preserve Area discussed above. The current concept for this area would provide 5.0 acres of habitat.

(J) Bridge NW Swale - 6.3

On the west side of the Rio Grande, south of Central Avenue, a location for Swales has been identified. These would become part of the South Preserve Area discussed above. The current concept for this area would provide 5.5 acres of habitat.

(K) Bridge NE Swale - 6.4

On the east side of the Rio Grande, just north of Bridge Boulevard, a location for Swales has been identified. The current concept for this area would provide 1.5 acres of habitat.

(E) Central NE Swale - 6.5

On the east side of the Rio Grande, just north of Central Avenue, a location for Swales has been identified. The current concept for this area would provide 4.0 acres of habitat.

(F) Central SW Swale - 6.6

On the west side of the Rio Grande, just north of Central Avenue, a location for Swales has been identified. The current concept for this area would provide 2.5 acres of habitat.

(C) Alameda Ditch Outfall Swale - 6.7

On the east side of the Rio Grande, between I-40 and Central Avenue, a location for Swales has been identified. These would become part of the North Preserve Area discussed above. The current concept for this area would provide 2.5 acres of habitat.

(G) Tingley #1 Swale - 6.8

On the east side of the Rio Grande, south of Central Avenue, locations for Swales have been identified. The current concept for this area would provide 2.0 acres of habitat.

(H) Sunset Swale - 6.9

On the west side of the Rio Grande, south of Central Avenue, a location for Swales has been identified. These would become part of the South Preserve Area discussed above. The current concept for this area would provide 1.5 acres of habitat.

(I) Tingley #2 Swale - 6.10

On the east side of the Rio Grande, south of Central Avenue, a location for Swales has been identified. The current concept for this area would provide 1.0 acres of habitat.

4.2.3 Bosque Features (Feature 7, 8)

A critical part of the project is to restore the understory and Shrub Thicket areas that have been largely cleared of non-native plants. Only planting, establishing and managing native plants can reverse the trend of dominance by non-native species. Restoring the native bosque forest with understory and shrub thickets in the Study Area would also be key to improving wildlife habitat.

Planting strategies would include the following:

1) **Seeding** with native grasses and forbs, such as Indian rice grass (*Oryzopsis hymenoides*), galleta grass (*Hilaria jamesii*), side oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and sunflower (*Helianthus annuus*) and in wetter areas, yerba mansa (*Anemopsis californicus*), emory sedge (*Carex emoryi*), and salt grass (*Distichlis stricta*). Specific species and mixes to be used would be determined based upon soil type and other site conditions. Specific mixes based on these local conditions will be decided upon based on the Plant Species Selection for Revegetation Typical Sites within the Albuquerque Bosque Wildfire Project (Parametrix, 2005) document. Seeding involves sowing seed via methods such as broadcasting, crimp and drill or hydro-mulching. Timing of seeding would be critical to the establishment of the vegetative cover. Late summer is usually the best time.

2) Tall pots**, container or plug planting** with native shrubs, such as peach leaf willow (*Salix amygdaloides*), New Mexico olive (*Forestiera neomexicana*), four wing saltbush (*Atriplex canescens*), chamisa (*Chrysothamnus nauseosus*), false indigo (*Amorpha fruticosa*), golden currant (*Ribes aureum*), three leaf sumac, woodbine, and in wetter areas, coyote willow (*Salix exigua*), black willow (*Salix nigra* var. *gooddingii*), and seep willow (*Baccharis salicifolia*) would be an important strategy for establishing woody plants. This method of planting refers to a method of planting small container plants, (1-5 gallon), accompanied by a pipe to the root zone though which water would be provided by hand from a truck until the plant is well established. Tall pots allow development of deep root systems capable of using subsurface soil moisture (USDA NRCS Fact Sheet). Container planting refers to planting small plants in small containers, and plug planting refers to planting small seedlings with the soil or growth medium. Coyote willows can also be planted directly in wet areas as live sticks. Coyote willow will be installed into the willow swales as they are constructed. Shrubs would be planted at various densities depending on what is currently at the location. If no native understory vegetation exists at a location, then shrub planting density would be higher. If there is existing native vegetation, then a lower density of native shrubs would be installed. Again, specific species to be planted would be based upon local site conditions as described in Parametrix 2005.

3) **Pole planting** of native trees, such as the Rio Grande cottonwood (*Populus fremontii* var. *wislizenii*), black willow (*Salix nigra* var. *gooddingii*) and peach leaf willow (*Salix amygdaloides*). Pole planting is the technique most frequently used in the restoration of riparian areas. Many of the pilot projects in the bosque have utilized pole planting, and according to AOSD, they have a 90 percent success rate (conversation with O. Hummel, 2002). Branches of cottonwoods and willows, 10 feet to 15 feet in length, are placed into holes that have been augered through the soil to the water table. Little maintenance is required beyond taking precautions to protect the young trees from beavers. Trees would be planted at a fairly low density since cottonwoods exist throughout the Study Area. They would be supplemented in some areas as needed but at a very low density and planted at least 50 feet from each other and/or existing trees. Willow trees are lacking in some areas of the Study Area and would be planted at a higher density in those areas.

Planting strategies would not include planting larger plants, such as balled and burlapped or container trees, because they would not be successful in the Study Area without significant irrigation. Restoration projects occasionally include temporary irrigation, and it would be physically possible to flood irrigate portions of the bosque from the drain if there were water rights allocated for that purpose. However, the Route 66 Project would not include irrigation due to the cost and the lack of availability of water and dedicated water rights.

The overall restoration strategy is to revegetate the bosque with shrubs and juvenile trees to re-create the missing native understory in bosque forest woodland areas and the native shrub thickets in open areas. At the same time, gaps are to be left in between the revegetated areas to create edge habitat, the richest type of habitat, and to leave firebreaks to limit the potential for catastrophic fire. Two types of features have been generated for revegetation of the bosque, 1) Bosque Patches, which restore the understory to the bosque forest and woodland areas and 2) Shrub Thickets, which restore dense shrubby zones to open areas where existing vegetation has been cleared and removed. The revegetation features are shown in **Figure 4.13**.

Seeding would be applied wherever restoration occurs. In firebreak areas, seeding is the only revegetation strategy proposed. Bosque Patch and Shrub Thicket areas would also receive pole planting of trees and tall pot, container, or plug planting of shrubs.

Maintenance and adaptive management would be important to the long-term success of the revegetated areas. Ongoing removal of non-native stump sprouts and volunteers would be necessary in all planted areas. In firebreak areas, the vegetation would have to be mowed or "brush-hogged" periodically, in order to maintain the function as a firebreak and to keep out woody plants. Monitoring of weeds will also be a key to the success of the project. Implementation of the *Albuquerque Bosque Noxious Weed Management Plan* (Parametrix 2007) which provides guidelines to managing for 'noxious weeds' after thinning of non-native woody vegetation, would be required for a successful project. In Bosque Patch and Shrub Thicket areas plants that die would have to be replaced. Maintenance and adaptive management will be further addressed in the Operations, Maintenance, Repair, Rebuild and Rehabilitate (OMRR&R) described in Section 5.2 below.

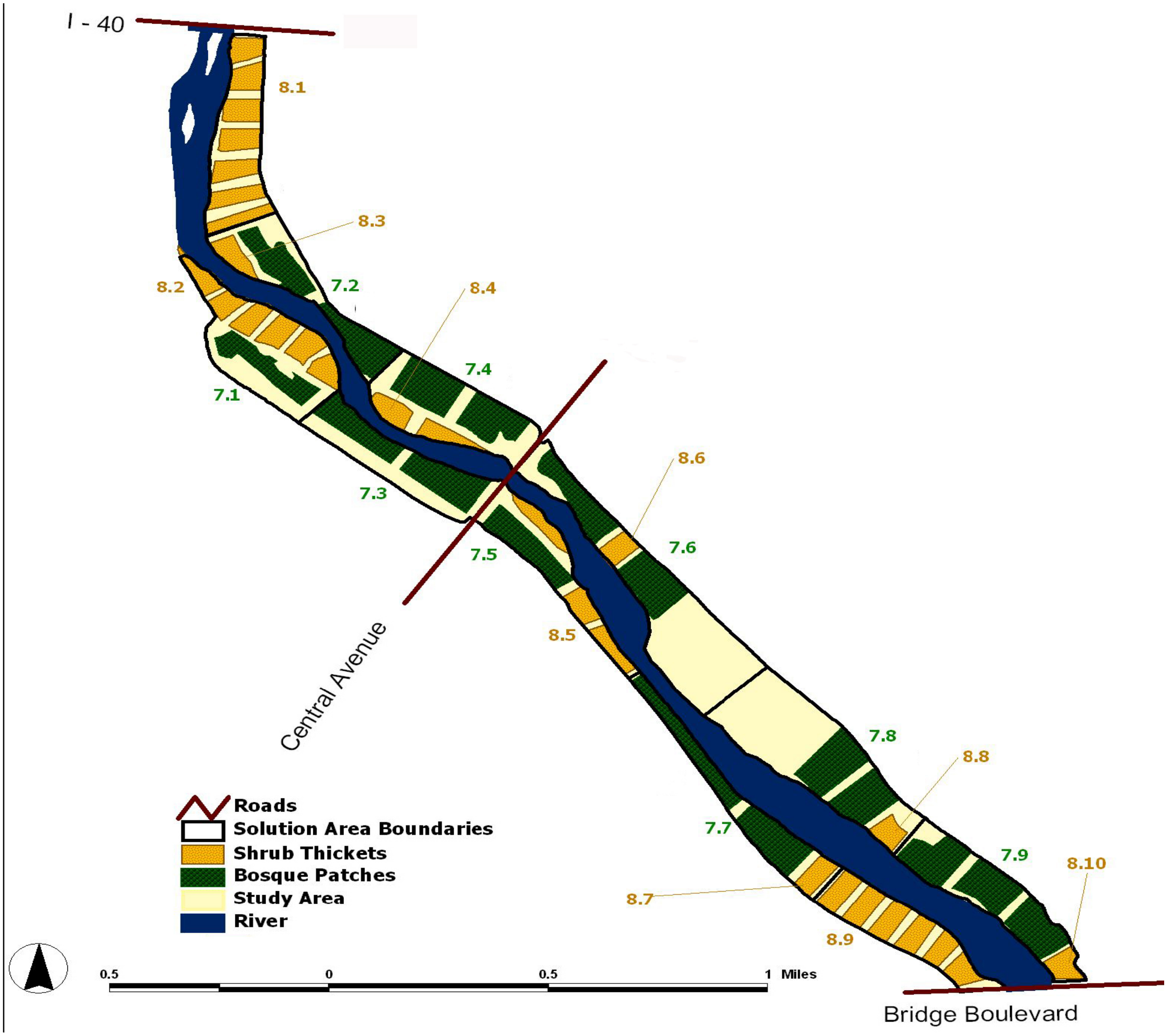


Figure 4.13 Revegetation Features

4.2.3.a Bosque Patches (Measures 7.0-7.9)

The size and configuration of Bosque Patch features were determined by the need for the patch to provide both core and edge habitat. The literature does not specify a minimum functional patch size, so the Project Development Team turned to recognized local experts in bosque wildlife, including Cliff Crawford, Professor Emeritus UNM, Deborah Finch, USFWS, and William DeRagon, Biologist, Corps. Through these conversations, the Project Development Team arrived at a figure of 8 to 10 acres, which would provide habitat for certain birds, and a number of small mammals and arthropods. In addition, each patch should have a continuous edge onto a firebreak, the levee, the river low-flow channel or some type of water-related feature.

The Bosque Patch feature would consist of replanting understory shrubs such as New Mexico olive, and plants that prefer partial shade such as *Amorpha* and golden currant. Other plants would be used depending on the following specific configuration of the site: existence of depressions, adjacency to water, southern exposure, etc. In addition, a limited number of cottonwood and black willow poles would be included to ensure age diversity of the forest overstory. **Figure 4.14** shows what this would look like in section and plan views.

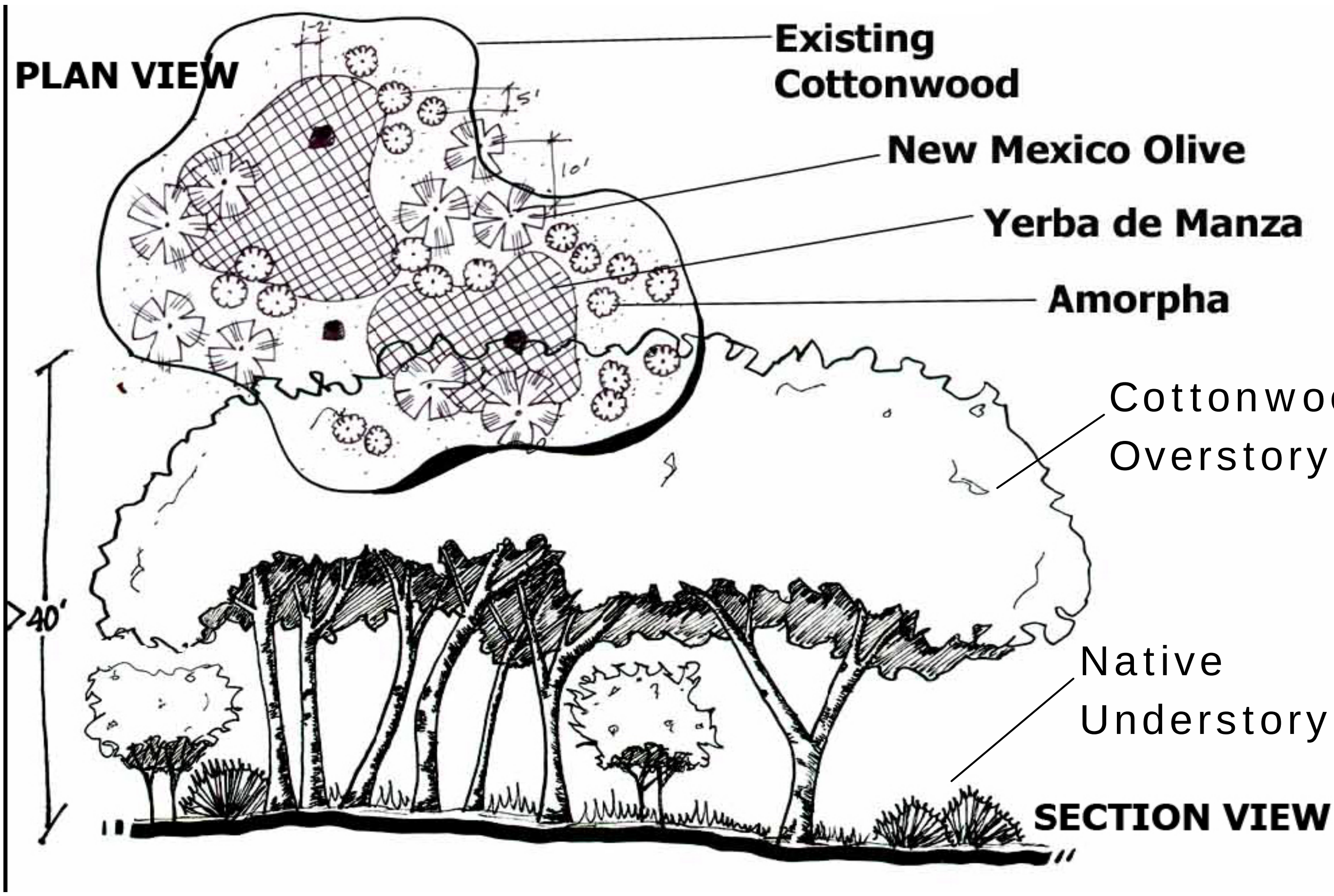


Figure 4.14 Schematic of a Bosque Patch in Plan and Section View

For the Bosque Patch feature the following management measures have been generated for specific locations in the Study Area:

Feature 7.0 – 7.9: Bosque Patches	
7.0	No Action
7.1	Atrisco Diversion
7.2	Alameda Ditch Outfall
7.3	Central NW
7.4	Central NE
7.5	Central SW
7.6	Tingley #1
7.7	Sunset
7.8	Tingley #2
7.9	Bridge NE

No Action - 7.0

No Bosque Patches would be created.

(B) Atrisco Diversion - 7.1

In the vicinity of the old Atrisco diversion on the west side of the Rio Grande, one Bosque Patch of approximately 8.2 acres is proposed.

(C) Alameda Ditch Outfall - 7.2

In the vicinity of the Alameda ditch outfall on the east side of the Rio Grande, two Bosque Patches totaling 16.8 acres are proposed.

(D) Central NW - 7.3

In the vicinity of the Central Avenue bridge to the north on the west side of the Rio Grande, 17.8 acres comprising two Bosque Patches are proposed.

(E) Central NE - 7.4

In the vicinity of the Central Avenue bridge to the north on the east side of the Rio Grande, two Bosque Patches totaling 17.9 acres are proposed.

(F) Central SW - 7.5

In the vicinity of the Central Avenue bridge to the south on the west side of the Rio Grande, one patch of approximately 9 acres is proposed.

(G) Tingley #1 - 7.6

In the vicinity of the Central Avenue bridge to the south on the east side of the Rio Grande, 18.7 acres consisting of two Bosque Patches are proposed.

(H) Sunset - 7.7

On the west side of the Rio Grande near the sunset irrigation outfall, two Bosque Patches totaling 18.3 acres are proposed.

(I) Tingley #2 - 7.8

Two Bosque Patches totaling 18.3 acres are proposed in the vicinity of the main Tingley pond on the east side of the Rio Grande.

(K) Bridge NE - 7.9

On the west side of the Rio Grande just north of Bridge Boulevard, four Bosque Patches totaling 24.9 acres are proposed.

4.2.3.b Shrub Thickets (Measures 8.0-8.10)

Size and configuration of Shrub Thicket features are also based on the need for the patch to provide both core and edge habitat. Again, there was no minimum patch size in the literature. As a result, the Project Development Team once again turned to recognized local experts in bosque wildlife and arrived at a figure of 3-5 acres, which would provide core habitat for certain birds and small mammals. In addition, like the Bosque Patch feature, each Shrub Thicket would have a continuous edge onto a firebreak, the levee, the river low-flow channel or some type of wet habitat feature.

In the Shrub Thicket feature would consist mostly of peach leaf willows, sumac, and seep willow; other plants would be utilized depending on the specific configuration of the site. In Swale and bank areas, the predominant shrub would be coyote willow. **Figure 4.15** shows what this would look like in section.

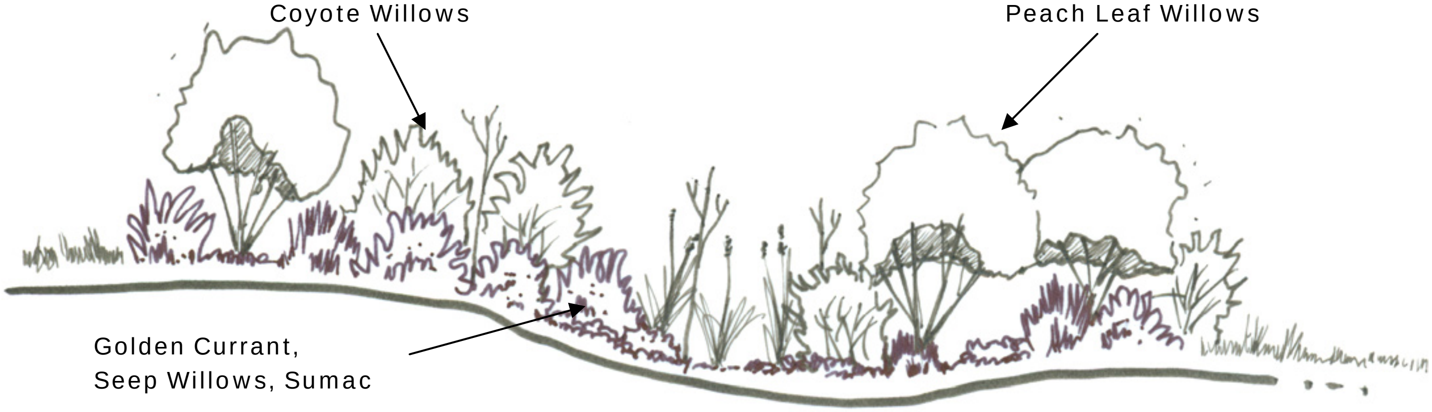


Figure 4.15 Schematic Design of a Shrub Thicket

For the shrub thickets feature the following management measures have been generated for specific locations in the Study Area:

Feature 8.0 – 8.10: Shrub Thickets	
8.0	No Action
8.1	I-40 South
8.2	Atrisco Diversion
8.3	Alameda Ditch Outfall
8.4	Central NE
8.5	Central SW
8.6	Tingley #1
8.7	Sunset
8.8	Tingley #2
8.9	Bridge NW
8.10	Bridge NE

No Action - 8.0

No shrub thickets would be created.

(A) I-40 South Shrub Thicket - 8.1

South of I-40 on the east side of the Rio Grande, 22.5 acres composed of seven shrub thickets is proposed.

(B) Atrisco Diversion Shrub Thicket - 8.2

In the vicinity of the old Atrisco diversion on the west side of the Rio Grande, six thickets totaling 17.3 acres are proposed.

(C) Alameda Ditch Outfall Shrub Thicket - 8.3

In the vicinity of the Alameda ditch outfall on the east side of the Rio Grande, 3.5 acres containing one thicket is proposed.

(E) Central NE Shrub Thicket - 8.4

In the area north of the Central Avenue bridge on the east side of the Rio Grande, three thickets totaling 6.6 acres are proposed.

(F) Central SW Shrub Thicket - 8.5

In the vicinity of the Central Avenue bridge to the south on the west side of the Rio Grande, an area totaling 9.3 acres comprised of three thickets is proposed.

(G) Tingley #1 Shrub Thicket - 8.6

In the south of the Central Avenue bridge on the east side of the Rio Grande, one thicket of 3 acres is proposed.

(H) Sunset Shrub Thicket - 8.7

On the west side of the Rio Grande near the Sunset irrigation outfall, one thicket of 3.3 acres is proposed.

(I) Tingley #2 Shrub Thicket - 8.8

In the vicinity of the main Tingley pond on the east side of the Rio Grande, one thicket of 2.7 acres is proposed.

(J) Bridge NW Shrub Thicket - 8.9

On the west side of the Rio Grande just north of Bridge Boulevard, six thickets totaling 19.8 acres is proposed.

(K) Bridge NE Shrub Thicket - 8.10

On the east side of the Rio Grande just north of Bridge Boulevard, an area totaling 18.8 acres with six thickets is proposed.

4.2.4 Interpretive & Recreational Enhancements (Measures 9.0-9.7)

Interpretive and recreational enhancements could facilitate long-term restoration in three ways: 1) by channeling recreation use to a designated trail system, thereby reducing the impact of recreational users elsewhere in the bosque, 2) by creating a series of access routes throughout the bosque that would enable Open Space Police and the Fire Department to respond quickly to emergencies, thereby reducing the potential of catastrophic damage, and 3) by creating resources for educating members of the public about the bosque, the restoration process and its stewardship.

The proposed recreational and interpretive features comprise approximately 5 percent of the total project cost. They are also specific to the Study Area as a whole, but not to various Solution Areas.

In the process of planning these enhancements, attention was given to the goals of increasing high value wildlife habitat and integration with other ongoing projects. Two areas were identified as potential wildlife refuge areas in which there would be no established trails, one in the northeast corner of the Study Area near I-40 and the other in the southwest corner of the Study Area by Bridge Boulevard. There are several ongoing projects in the bosque to which the Project wanted to provide access such as the Bio-Park Project wetlands, the AOSD Zoo Burn wetland area and the Rio Grande Restoration Demonstration Project. The project would provide connections to several new projects outside the levees such as the Valle del Bosque Park and the Bio-Park Tingley Ponds Projects, thus allowing the more active Bio-Park recreational activities to take place outside the bosque. Proposed interpretive and recreational enhancements and their relationship to other projects and recreational areas are shown in **Figure 4.16**.

For the Interpretive and Recreational Enhancements feature the following management measures have been generated:

Feature 9.0 – 9.7:	**Interpretive and Recreational Features**
9.0	**No Action**
9.1	**Stabilized Crusher Fines Trail**
9.2	**Soft Surface Trail**
9.3	**Boardwalk**
9.4	**Bridge**
9.5	**Wildlife Blinds**
9.6	**Benches**
9.7	**Interpretive Signage**

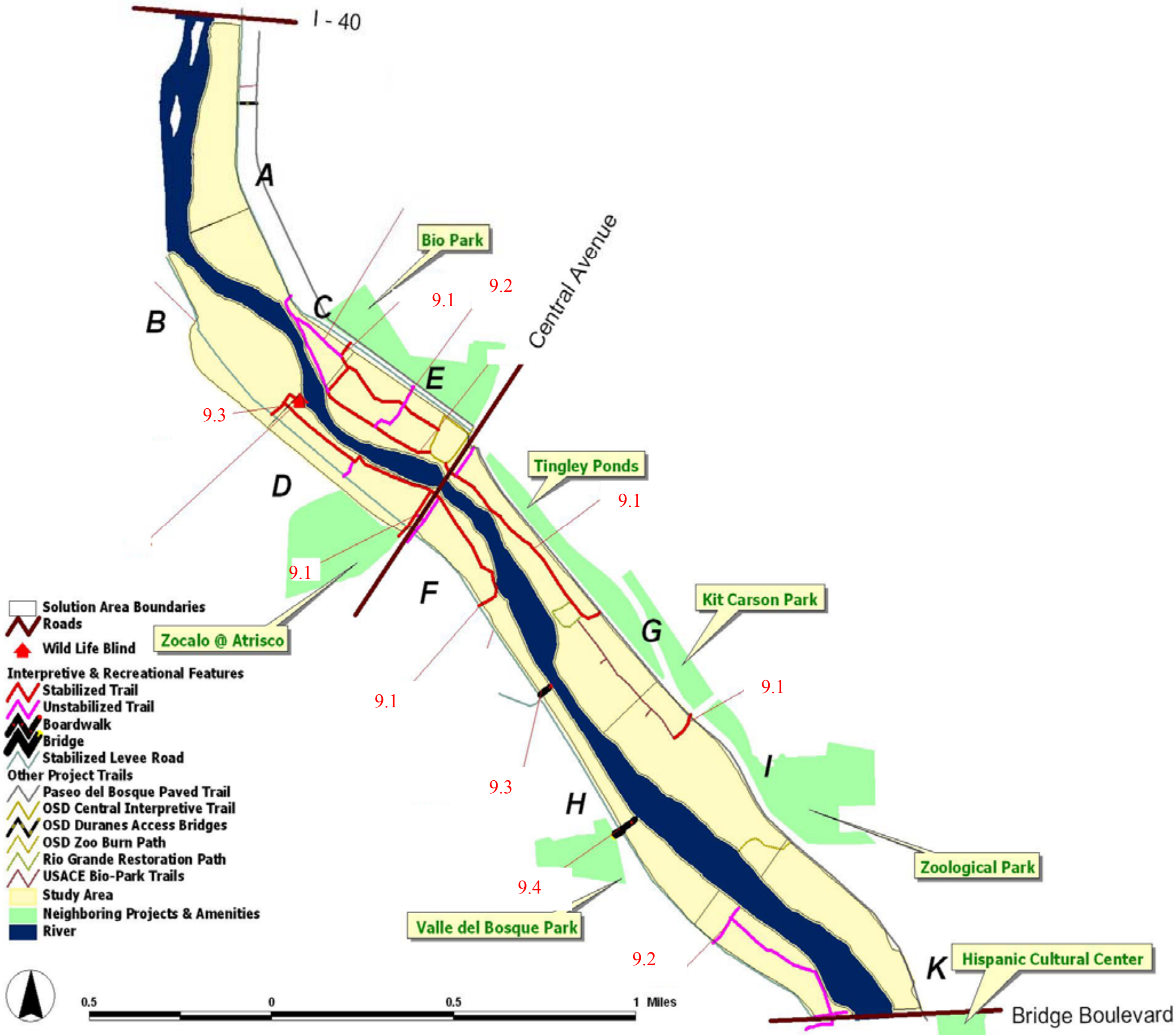


Figure 4.16 Interpretive and Recreational Features

No Action Measure – 9.0

No Interpretive or Recreational features would be installed.

(B, C, D, E, F, G, I) Stabilized Crusher Fines Trail - 9.1

Approximately 6,700 linear feet of stabilized crusher fines trails are proposed. These trails would be the primary circulation system within the bosque and would loop up to the levee. Most of this new trail would be found in the vicinity of Central Avenue, in order to accommodate and limit the impact of primary access points for most users of the bosque in this portion of the Rio Grande Valley State Park.

(C, E, F, G, J) Soft Surface Trail - 9.2

Approximately 23,000 linear feet of soft surface trails are proposed. These trails would create loops, and in some cases, connect the levee to the river. They would be constructed of crusher fines to give them a material edge and permanence.

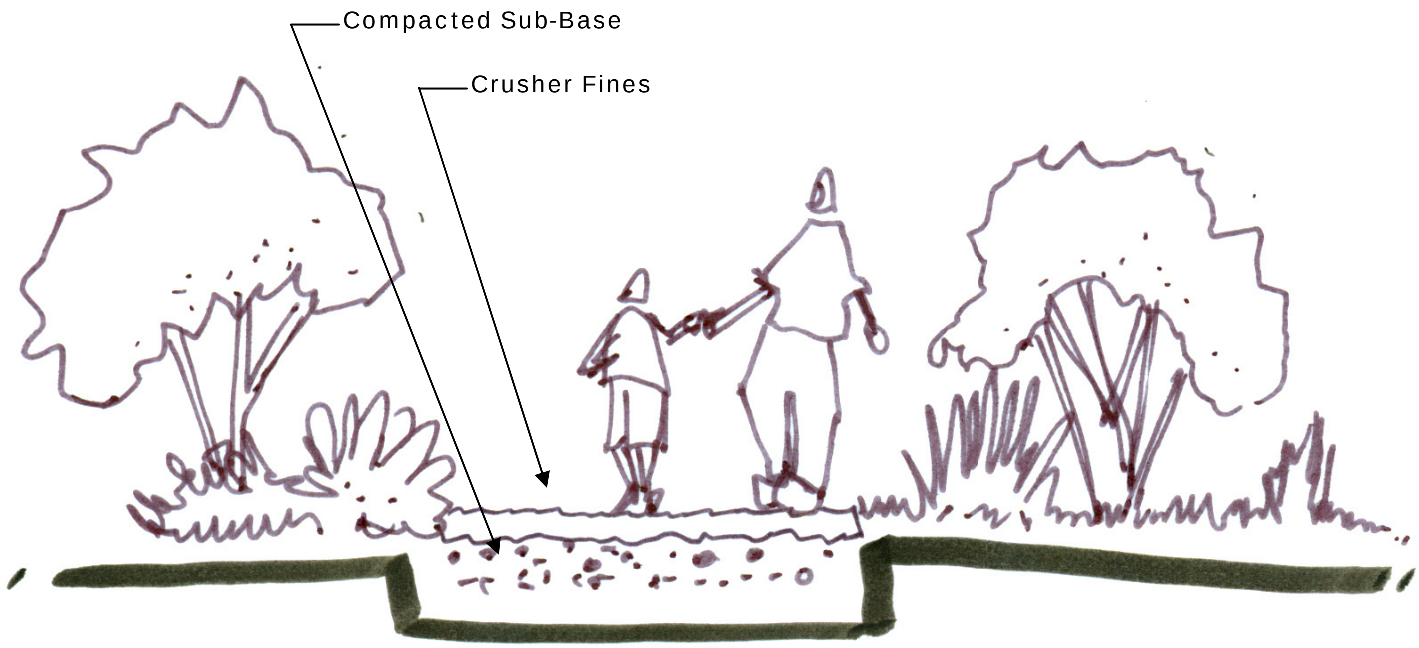


Figure 4.17 Soft Surface Trail

(H) Boardwalk - 9.3

One boardwalk is proposed for the Study Area on the west side in Solution Area H, which is extremely narrow. This boardwalk would start out at the same level as the levee and then gently slope down into the bosque and wind under the canopy of the bosque to the river's edge. They would extend out to the river, permitting passive recreational and educational users to access the river and have another kind of experience of the bosque at the tree level without compacting soils or disturbing wildlife.

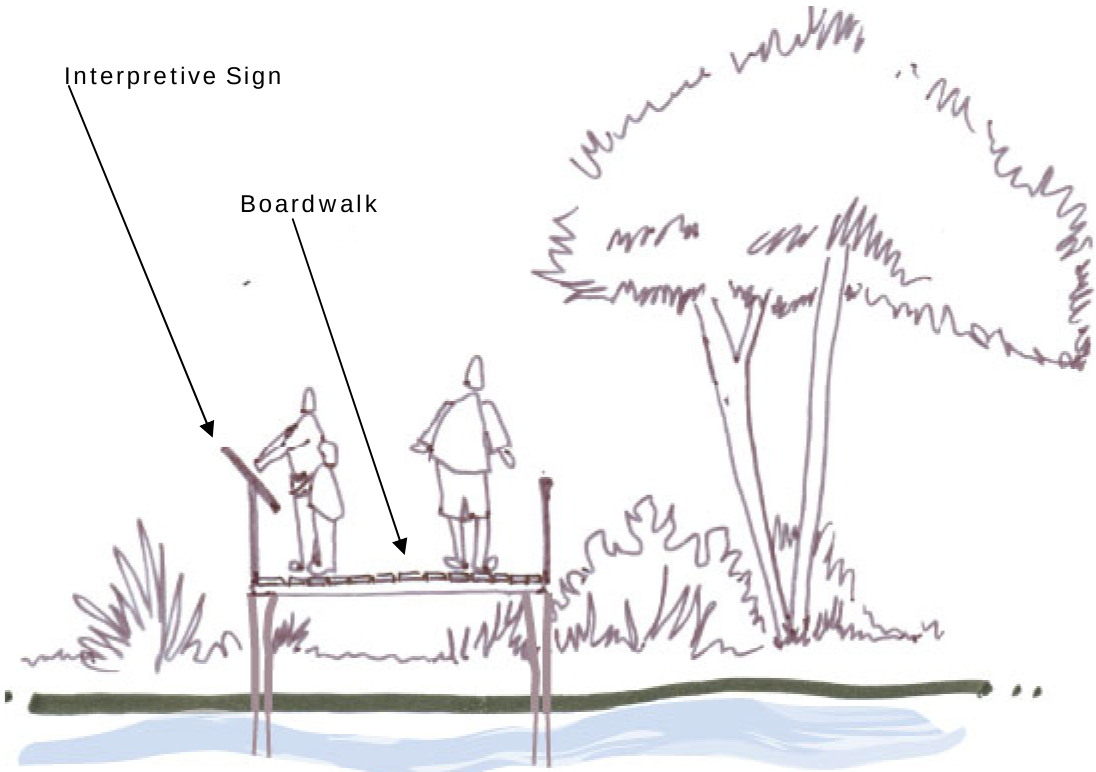


Figure 4.18 Boardwalk and Interpretive Signage

(H) Bridge - 9.4

A single drain-crossing bridge is proposed to connect the Bernalillo County Valle del Bosque Park across to the bosque, thereby enabling the park to accommodate parking and more active recreational users.

(D) Wildlife Blind - 9.5

A single wildlife blind is proposed for the south bank of the wasteway for the Atrisco Header. The soils are often moist in this area, with significant numbers of birds, and there is a tremendous view out onto the river with the Sandia Mountains in the background.

(A-K) Benches - 9.6

Twenty benches are proposed to provide seating for users of the trail system. The benches are proposed to be set out along the trails and the levee approximately every quarter mile.

(A-K) Signage - 9.7

Twenty signs are also proposed to provide educational and interpretive moments as users move through the bosque. They would help people to understand how the bosque functions and what has transpired in this particular portion of the bosque.

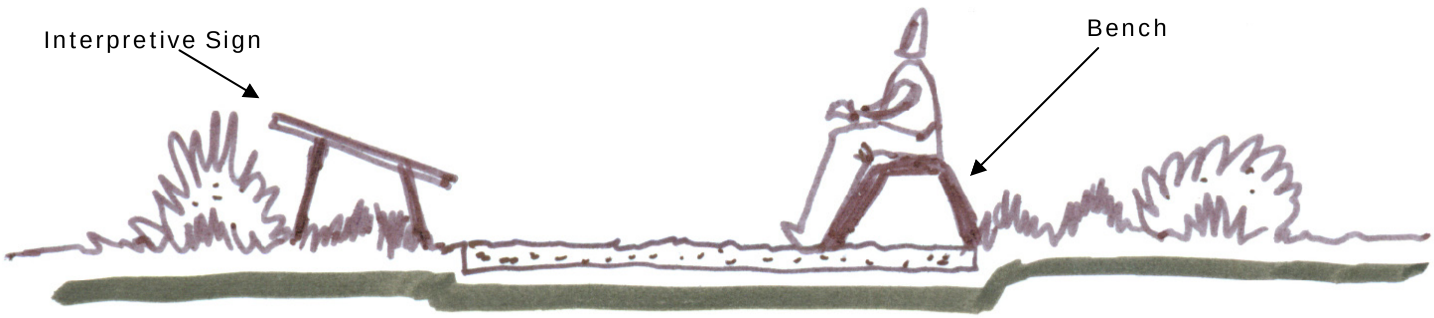


Figure 4.19 Interpretive Sign and Bench

4.3 Habitat Units

To compare the cost effectiveness of restoration features within solution areas, an environmental out put is required. This output is termed Habitat Units (HUs) and is the quantification of expected improvements in targeted functions related to the project objectives. For the Route 66 Project, HUs are equal to the acres of proposed restoration measures so that a 10-acre Bosque Patch and a 2.5-acre High-Flow Channel were assumed to generate 10 and 2.5 HUs respectively. During the run of the Incremental Cost Analysis (ICA), the Project Delivery Team determined that water features should receive a higher weight than non-water features. The ICA is further described below and in Technical Appendix E. As discussed in Section 1.7, the overall goal and objective of this Study is to restore a more naturally functioning bosque ecosystem by increasing the amount of native-dominant vegetative communities, improving the diversity of native riparian vegetation communities, reducing the number and size of non-native dominant stands, and improving the hydraulic connection between the bosque and the Rio Grande. In accomplishing these goals, the chance of catastrophic fires would be greatly reduced and the operations and maintenance requirements that become the local sponsor's responsibilities, would also be minimized.

Projected costs were based upon construction costs plus management costs over the 25-year life of the project. Habitat units were not estimated for the No Action alternatives because the sponsor and the project team were only concerned with new habitat units. The various measures, habitat units and costs, for each of the features were aggregated by Solution Area to create a composite set of solutions, as shown in **Figure 4.20**. This figure shows all the features summarized together by Solution Area.

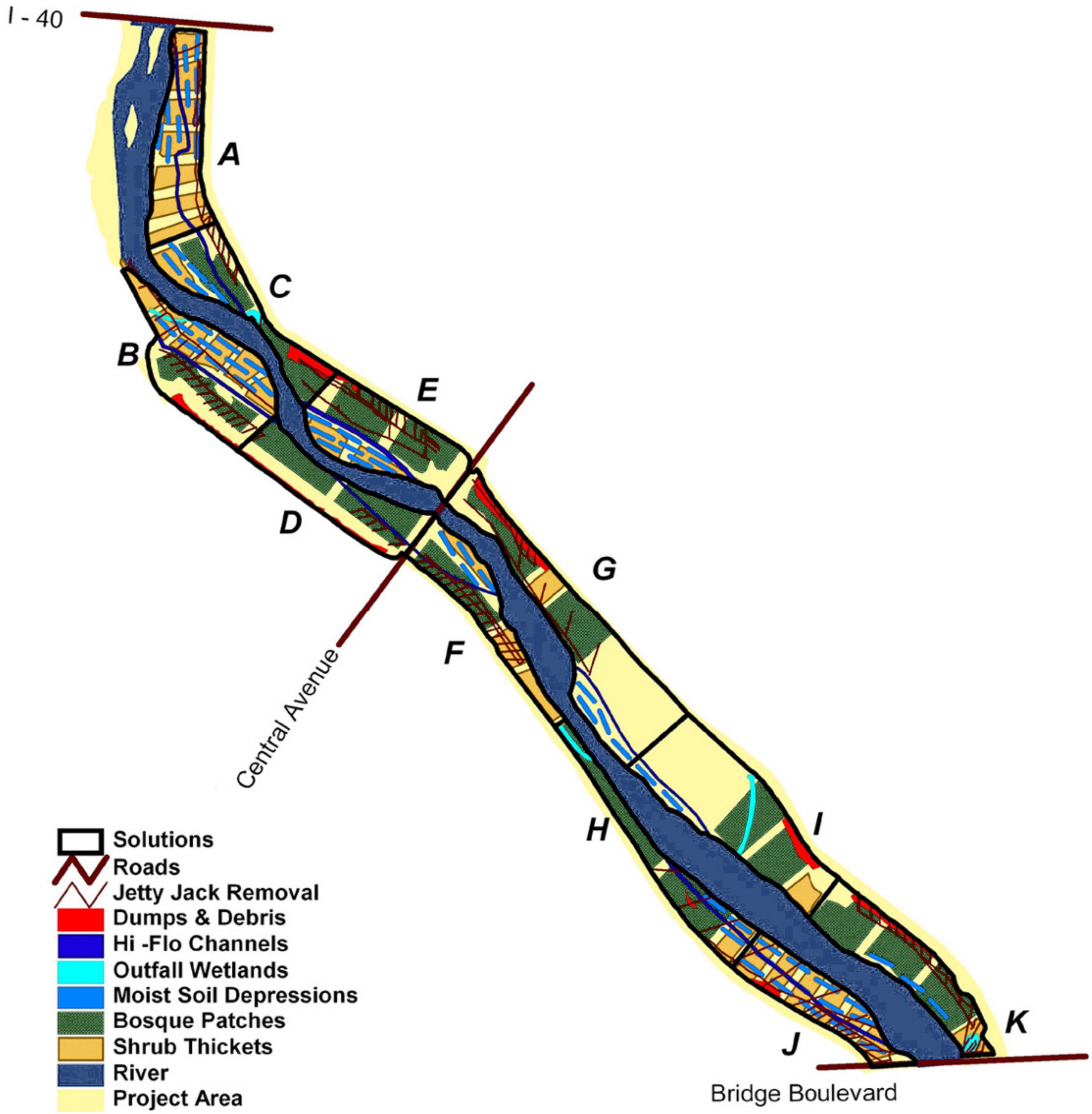


Figure 4.20 Summary of Management Measures

Table 4.3 presents a summary of management measures aggregated by restoration solution areas, the net habitat units created and the average annual cost for management. Solution Areas differed in the number and types of features present. The average annual cost and habitat units were calculated for each Solution Area. Habitat units ranged from 35 in Solution Area B down to 18.7 habitat units in Solution Area D. Average annual costs ranged from around $66,000 up to nearly $138,000. The Solution Areas were then input for the Corps IWR-Plan Software Program (IWR-Plan), in order to generate a series of alternatives. Each alternative would be a combination of one or more Solution Areas.

4.4 Economic Analysis

4.4.1 Incremental Cost Analysis & Plan Evaluation (NER)

The following section presents the results of the cost-effectiveness and incremental cost analyses (CE/ICA) of possible ecosystem restoration alternatives for the Study Area. Cost-effectiveness analysis identifies the least-cost solution for each level of environmental output. Incremental cost analysis shows the incremental changes in costs for increasing levels of environmental outputs. These analyses were conducted using the Corps software program IWR-PLAN. A detailed description of the CE/ICA is provided in Technical Appendix E.

4.4.1.a Process

The eleven potential Solution Areas were developed to carry out environmental restoration in the Study Area. Each Solution Area as described above consists of a combination of removal and restoration features targeted to one of eleven specific sub-areas within the Study Area. The possible Removal Features include Removal of Jetty Jacks, Non-Native Vegetation, and Debris. The possible restoration features include Bosque Patches, Shrub Thickets, and water-related habitat features such as High-Flow Channels, Swales and Outfall Channels. Environmental output measures (the average annual habitat acreage created) and cost measures (the average annual dollar cost of the restoration activities) were developed for each management measure as the input variables for the analysis. The management measures are summarized in **Table 4.3**.

IWR-PLAN combined these management measures in different ways to obtain the various environmental restoration plans. The IWR-Plan model for this project accounted for the savings and lower habitat unit values resulting from selecting adjacent solution areas that share a High-Flow Channel. A ten percent reduction in costs was also accounted for by the selection of adjacent solution areas because of the potential for sharing mobilization costs.

Table 4.3 Summary of Restoration Features by Solution Areas

Solution Area	Removal Features		Restoration Features		Net Habitat Created
A	Jetty jacks: Non-native vegetation:	192 9.3 ac	High-Flow Channel: Swale: Shrub thicket:	2.3 ac 5.0 ac 22.5 ac	23.2 HUs
B	Jetty jacks: Non-native vegetation: Dump:	308 7 ac 46,864 cy	Outfall Channel: High-Flow Channel: Swale: Bosque patch: Shrub thicket:	2.1 ac 3.7 ac 5.5 ac 8.2 ac 17.3 ac	25.7 HUs
C	Jetty jacks: Dump: Non-native vegetation:	153 109,151 cy 3 ac	Outfall Channel: Swale: Bosque patch: Shrub thicket:	0.3 ac 2.5 ac 16.8 ac 3.5 ac	20.0 HUs
D	Jetty jacks: Dump:	87 27,906 cy	High-Flow Channel: Bosque patch:	0.9 ac 17.8 ac	18.3 HUs
E	Jetty jacks: Dump:	278 23,477 cy	High-Flow Channel: Swale: Bosque patch: Shrub thicket:	1.6 ac 4.0 ac 17.9 ac 6.6 ac	30.1 HUs
F	Jetty jacks: Non-native vegetation:	287 25 ac	High-Flow Channel: Swale: Bosque patch: Shrub thicket:	0.9 ac 2.5 ac 9.0 ac 9.3 ac	21.3 HUs
G	Jetty jacks: Non-native vegetation: Dump:	254 24.8 ac 153,902 cy	High-Flow Channel: Swale: Bosque patch: Shrub thicket:	0.9 ac 2.0 ac 18.7 ac 3.0 ac	13.7 HUs
H	Jetty jacks: Non-native vegetation: Dump:	80 25.0 ac 7,964 cy	High-Flow Channel: Swale: Outfall Channel: Bosque patch: Shrub thicket:	2.6 ac 1.5 ac 1.0 ac 18.3 ac 3.3 ac	24.1 HUs
I	Non-native vegetation: Dump:	33 ac 86,273 cy	Outfall Channel: High-Flow Channel: Swale: Bosque patch: Shrub thicket:	1.8 ac 0.9 ac 1.0 ac 18.3 ac 2.7 ac	9.4 HUs
J	Jetty jacks: Non-native vegetation: Dump:	355 27.3 ac 35,555 cy	High-Flow Channel: Swale: Shrub thicket:	2.6 ac 5.5 ac 19.8 ac	26.9 HUs
K	Jetty jacks: Non-native vegetation: Dump:	286 26.9 ac 81,633 cy	Outfall Channel: Swale: Bosque patch: Shrub thicket:	0.4 ac 1.5 ac 24.9 ac 18.8 ac	20.5 HUs

4.4.1.b Results

The cost-effectiveness analysis identified as cost-effective and within the project budget, 51 from among 807 possible combinations of management measures (**Figure 4.21**). These 51 plans represent the highest environmental output at the least cost.

Three Solution Areas did not appear in any of the cost-effective plans–measures B, G, and I. These Solution Areas have the highest cost per acre of habitat created. In the case of measures G and I, a comparatively large amount of habitat already exists in the targeted areas, so the net increase in habitat as a result of the proposed management measures is not significant compared to other areas. The incremental cost analysis identified six "best buy" plans from among the 51 cost-effective plans. (Included in this group is the "No Action Alternative" option.) These plans are the most efficient in generating environmental outputs; in other words, they have the lowest incremental costs per unit of environmental output.

Figure 4.21 Cost Effective Plans

Figure 4.22, Best Buy Plans Incremental Cost Analysis Graph, shows the incremental cost analysis for the six best buy plans including the "No-Action Alternative." **Table 4.4** shows the best buy plans within the budgetary range for this project. While the net Habitat Units (HUs) created increase with each additional feature, the incremental cost may not be acceptable when comparing plans, such as the increase in cost per HU between Plan 5 and Plan 6. This comparison will be analyzed in Section 4.5, below.

Table 4.4 Summary of Best Buy Plans

Plan Alternative	Description	Incremental Output	Incremental Cost per HU	Net HUs Created
Plan 1	No-action	0	$0	0
Plan 2	H	24.1 HUs	$146	24.1
Plan 3	EH	30.2 HUs	$118	54.2
Plan 4	DEFH	45.4 HUs	$79	99.6
Plan 5	DEFHJ	26.9 HUs	$137	126.5
Plan 6	ADEFHJ	23.2 HUs	$163	149.7

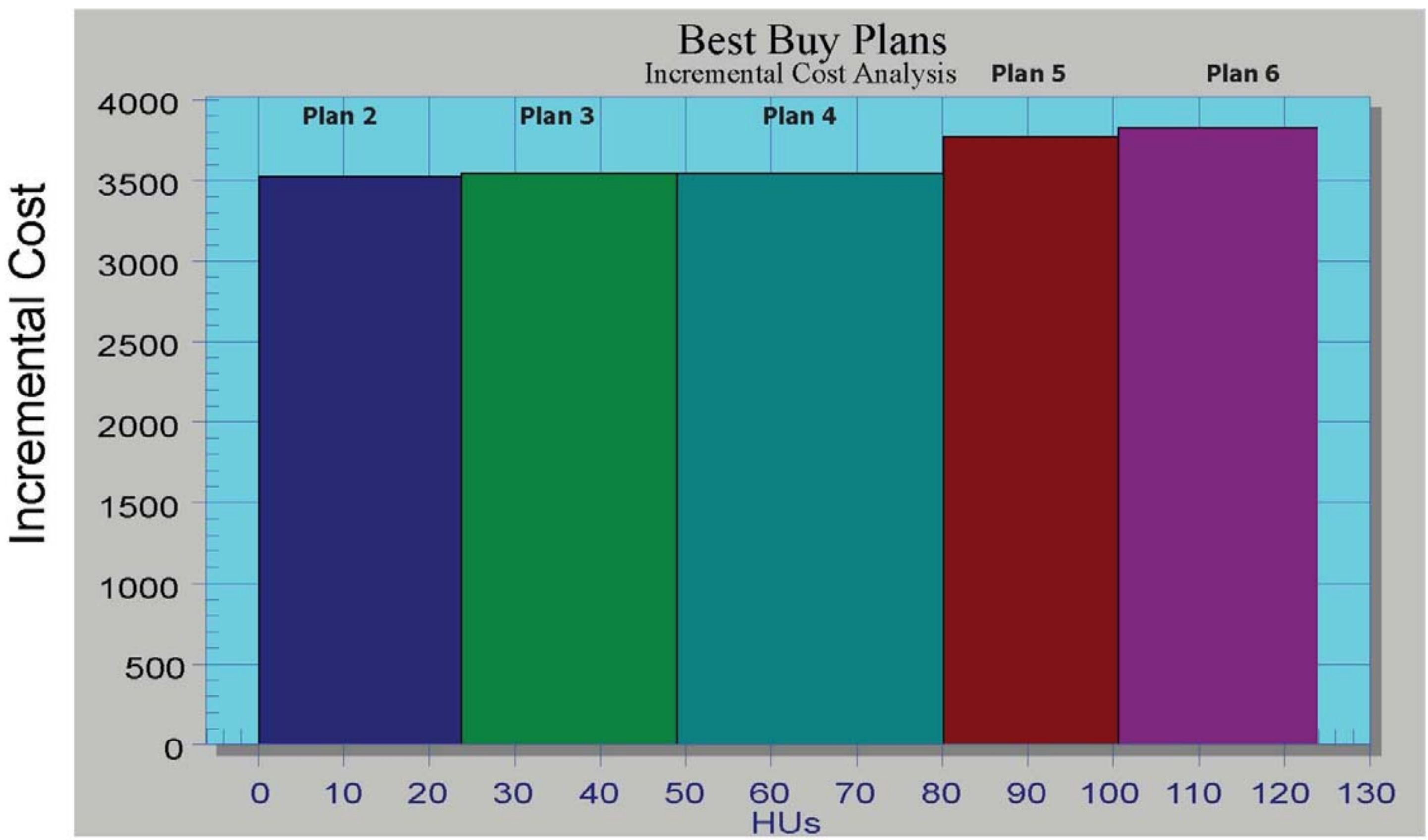


Figure 4.22 Best Buy Plans Incremental Cost Analysis Graph

In each of the best buy alternatives, a suite of Water-Related Features and Bosque Patches would be created in addition to Removal Features relevant to the particular Solution Areas. Solution Area H includes Outfall Channel Habitat, High-Flow Channels, Swales, Bosque Patches and Shrub Thickets. Solution areas H and E together would provide even more of these types of features and would also include shrub thickets. The addition of Solution Areas D, F and J, brings in features of all types. The overall number of habitat units would also increase significantly with each successive Solution Area added, as seen in Best Buy Plan 6. Total new HUs created would range from 20.8 to 122.3. Total restoration costs vary from approximately $1.04 million to $5.6 million.

4.4.2 Economic Analysis of Interpretive & Recreational Features (NED)

This section contains a benefit-cost analysis for the interpretive and recreational features proposed for the Study Area. Five percent of the total project budget construction costs was allowed to be spent for interpretive and recreational features as selected by the sponsor and stakeholders. The analysis compares the benefits resulting from the proposed interpretive and recreational facilities with the costs to build and maintain them. A benefit/cost ratio that is greater than one (1) indicates that the expected benefits justify the expected costs.

To determine the benefits from the interpretive and recreation facilities, annual use levels were estimated and converted into dollar values. The annual number of user days was estimated based on the number of annual visitors at other regional outdoor recreation destinations. The unit day value method (UDV) was then used to determine the annual dollar value of interpretive and recreation activities in the Study Area. Finally, a benefit-cost ratio was obtained by dividing these dollar amounts by the annualized costs for construction, operations and maintenance of the facilities.

The proposed recreation improvements include the following features:

- 13,900 feet of stabilized crusher-fines trail
- 8,600 feet of crusher-fines trail
- One boardwalk
- One pedestrian bridge
- 20 benches
- One wildlife blind
- 20 interpretive signs

4.4.2.a. Current Supply of Similar Recreational Facilities

Residents of Albuquerque have ready access to a wide array of places in the metropolitan area where they can engage in outdoor recreational activities such as hiking, bicycling, picnicking, wildlife observation, and other outdoor pursuits. However, the Rio Grande bosque is a unique natural feature in the City and the surrounding region. It is the only riparian area of any significant size and, as such, accounts for a substantial part of the wildlife habitat in the area and a critical urban oasis for residents and visitors. The cottonwood trees with the shrub and herbaceous undergrowth (both native and exotic) provide a relatively cool and shady refuge from the surrounding desert grasslands and city pavement.

4.4.2.b Current Use and Conditions of Similar Recreational Facilities

The Study Area lies within the Rio Grande Valley State Park. It receives heavy use from walkers, joggers, equestrians, and bicyclists along its estimated 24.6 miles of trails, although precise numbers are not available.

The current trail network is poorly configured; duplicate trail segments run throughout the Study Area. The use of informal trails in some places has caused deterioration of vegetation and disrupted wildlife habitat. Additional improvements such as benches, signs and wildlife observation blinds would greatly enhance this resource.

4.4.2.c Cost-Benefit Analysis

The City of Albuquerque Open Space Division estimates the number of people who annually use the various Open Space areas that it manages; however, visitors to many Major Public Open Space Areas, such as the bosque, are difficult to track due to size and the existence of multiple points of access. The Elena Gallegos Open Space Park in the Sandia foothills is able to better track numbers of visitors because visitors must pay a user fee at an entrance gate, permitting Open Space staff to count the number of vehicles entering the area. The Elena Gallegos Open Space facility covers 640 acres and offers an extensive network of trails that wind through pinion and juniper woodlands as well as toilet facilities. Trails are accessible to hikers, bicyclists and equestrians. A wildlife blind at a pond provides opportunities for wildlife observation. Visitors can also picnic at several developed sites. **Table 4.5**, Estimated Visitors to Open Space Areas, shows the estimated number of visitors to the Elena Gallegos Open Space area based on the annual vehicle counts. This number does not reflect the number of visitors not entering through the main entrance.

Table 4.5 Estimated Visitors to Open Space Facilities

Year	Petroglyph National Monument	Elena Gallegos Open Space
FY 1996	29,702	-
FY 1997	58,436	-
FY 1998	61,013	-
FY 1999	53,282	-
FY 2000	61,170	-
FY 2001	60,608	131,000
FY 2002	53,299	110,822
FY 2003	52,266	115,000*
Average	**53,722**	**118,941**

Another outdoor recreational area that draws visitors from throughout the nation as well as the community is the Petroglyph National Monument, which is part of the National Park System. This facility covers 7,232 acres along the west side of Albuquerque and contains an estimated 25,000 petroglyphs (images carved into the volcanic stone by native peoples and early Spanish settlers). Visitors can learn about the park's natural and cultural features and the schedule of activities at the visitor center. Several trails provide opportunities for viewing the petroglyphs and the area's unique geology and wildlife. The amenities include picnic tables, restrooms and a water fountain.

Table 4.5 also shows the number of visitors to the Petroglyph National Monument Visitor Center. It should be noted that these figures do not include people who visit the monument without going to the visitor center. It is likely that the actual number of visitors is significantly higher.

For the purposes of this analysis, it is assumed that the Study Area is comparable to the Elena Gallegos Open Space Park and the Petroglyph National Monument in the number of visitors that it draws. Current annual use of the Study Area is thus conservatively estimated to be 75,000 user days. Further, it is assumed that the Study Area can expect to see a 10 percent increase in use due to the improved recreational facilities and the intrinsic interest in the restored bosque.

The unit day value method was used to assign a dollar value to current use of the Study Area as well as to future use after completion of the proposed improvements. **Table 4.6** shows the general recreation costs and benefits for the Study Area before and after improvement and the resulting user day dollar values of $4.19 and $6.64, respectively.

The recreational value of the proposed improvements can be divided into two components: the increase in value of the existing level of use, and the overall increase in the level of use.

Table 4.6 Costs & Benefits of Interpretive & Recreational Features

	Unit	Amount	Construction Cost	Annual OMRR&R
Stabilized crusher fines trail	lf	13,900	$180,700.00	$2,755.50
Crusher fines trail	lf	8,600	$55,900.00	$9,425.63
Boardwalk/bridge	ea	2	$62,500.00	$2,500.00
Benches	ea	20	$37,500.00	$2,500.00
Wild life blind	ea	1	$25,000.00	$750.00
Bridge	ea	1	$31,250.00	$1,250.00
Signage	ea	20	$25,000.00	$1,250.00
TOTAL			**$417,850.00**	**$20,431.13**

Cost of Proposed Interpretive & Recreational Features	
Total Construction Cost	$417,850
Average Annual Construction Cost	$31,531
Average Annual OMRRR	$20,431
Total Average Annual Cost	$51,962

Value of Benefits of Proposed Interpretive & Recreational Features	
Current annual use	75,000
Estimated annual use after improvements	82,500
Estimated increase in use after improvements	7,500
Unit Day Value (UDF) After Improvements	$6.64
Unit Day Value (no action)	$4.19
Increase of UDV	$2.45
Annual recreational value due to increased UDV	$183,750
Annual recreational value due to increased use	$49,800
Total annual recreational value	$233,550

The annual Study Area recreational value due to the increased unit day value alone, without considering an increase in use, is $183,750. The annual Study Area recreational value due to an increase in use is $49,800. The total annual recreational value thus amounts to $233,550. The total average cost of the recreation and interpretive features are $51,962.00. Therefore, the benefit/cost ratio is approximately 4.5, which is greater than one (1), which means the benefits of the proposed features outweigh the costs as outlined above in **Table 4.6**.

4.5 Comparison of Selected Alternatives

4.5.1. Description of Alternative Plans Considered and Rejected

A number of alternatives were considered and rejected, including the following:

4.5.1.a No Action Alternative Plan

Future conditions without project implementation were projected to characterize the "No Action" alternative and its effects, and to form a basis for comparison of restoration benefits. Throughout the Middle Rio Grande Valley, the river, floodplain, and the associated fish and wildlife populations would be expected to continue to experience adverse effects from new and ongoing Federal, State, and private water resource development projects. Additionally, increasing urbanization and development within the historic floodplain would continue to eliminate remnant riparian areas located outside the levees, putting increased pressure on the habitat and wildlife in the riparian zone within the floodway. Local agencies would continue to perform maintenance of non-native vegetation as they are able, but the features connecting the bosque and river would not be constructed.

4.5.1.b All Features Alternatives

An “All Features Alternative” was briefly considered, but rejected for budgetary reasons. The cap on the budget for 1135 projects is just under $7 million. Since the All Features Alternative would cost more than the cap set by legislative authority, and the incremental increase in habitat units was minor, it was rejected. All Features Alternatives by class or type of feature, (e.g., all water related features, all bosque features) were also considered singly, but rejected because by focusing on only one habitat type, they would not satisfy the goal of creating a dynamic mosaic in the bosque.

4.5.1.c Removal Features Only Alternative

Although not generated by the Incremental Cost Analysis, a “Removal Only” alternative was considered. This alternative would consist of all of the Removal Features, i.e., the removal of all non-native vegetation, dead and down wood, dumps and debris and jetty jacks in the Study Area. This alternative is consistent with the project goals of improving the health of the native bosque and reducing the fire hazard of the bosque. Under this alternative, however, there would be no revegetation other than seeding in areas of major disturbance from the removal process. The Removal Only alternative would enable native plants to have a better opportunity to succeed in the bosque, but no new habitat would actually be created directly by this alternative in the near term. There would be little possibility of re-establishing the dynamic mosaic in the bosque. No additional wet habitat or other water-related features would be created. Woodland, savannah and open areas would predominate, and there would be few, if any, bosque patches with the understory that are crucial to wildlife diversity in the bosque (Pittenger 2003; Hink and Ohmart 1984). Under this alternative, no additional recreational elements would be created, which is inconsistent with the current intensity of recreational use of the Study Area. For these reasons and for the reason that the Corps Bosque Wildfire Project and AOSD’s fuel reduction efforts may complete much of the removal process, this alternative was rejected.

4.5.1.d Alternatives with Significant Recreational and Interpretive Features

Alternatives that contained more intensive recreational features such as paved trails, pavilions, restrooms, picnic areas, etc., within the solution areas were considered. However, this would increase the amount of human disturbance in the Study Area. The Route 66 Project’s primary goal was to restore the bosque and the wildlife habitat it provides by channeling recreational use to fewer, designated areas, thereby reducing the impact of recreational users elsewhere in the bosque. Furthermore, although this portion of the bosque sustains the greatest amount of recreational use, it does not warrant greater expenditures than that typically allocated for Section 1135 projects at the expense of restoration features. Corps Policy Guidance Letter No. 59, "Recreation Development at Ecosystem Restoration Projects" limits recreational features to ten percent of project costs, unless prior approval from the Assistant Secretary of the Army (Civil Works) is obtained. The guidance further indicates that this limit "…. should be viewed as an upper limit on Federal cost sharing and not as a goal for expenditures." Therefore, alternatives that included significant recreational and interpretive features were also rejected.

4.5.1.e Other Cost-Effective Plan Alternatives

Other cost-effective plans generated by the Incremental Cost Analysis were eliminated as alternatives in favor of the Best Buy Plans. In addition, a number of the Solution Areas not selected as part of one of the Best Buy Plans have significant existing habitat and/or are likely to be the focus of restoration activities as part of the other projects being undertaken in the Albuquerque reach by Corps. For example, Solution Areas G and I are included in the Bio-Park Project's created wetlands. Solution Areas A, B and C are to be addressed as part of the Bosque Wildfire Project.

4.5.1.f Alternatives from Best Buy Plans 2, 3, and 4

Best Buy Plans 2, 3 and 4 were also evaluated. All three of these alternatives were composed of various mixes of habitat types and resulted in varying levels of habitat units ranging from 24.1 to 99.6 (**Table 4.4**). Best Buy Plans 2, 3 and 4 were rejected primarily because the target goal percentage for Shrub Thicket habitat (**see Table 4.3**) was not met and the total acreage of Bosque Patch habitat would have exceeded 50 percent. Although all of the Best Buy Plans (other than the No Action alternative) had larger percentages of wet habitat, the skewed distribution toward Bosque Patch was counter to the overall goal of the Study to restore the dynamic mosaic of the bosque. The percentages of various habitat types that would be generated by the Best Buy Plans are shown in **Table 4.7**.

Table 4.7 Comparison of Best Buy Plans

Plan # and Description	Total HUs Created	Water Feature Habitat %	Bosque Patch Habitat %	Shrub Thicket Habitat %	Other % (Fire Breaks)
Plan 6 ADEFHJ	149.7	16	34	33	17
Plan 5 DEFHJ	126.5	15	41	25	18
Plan 4 DEFH	99.6	12	51	16	22
Plan 3 EH	54.2	16	54	15	15
Plan 2 H	24.1	18	65	12	5

4.5.1.g Best Buy Plan 6 Alternative

The primary difference between the Best Buy Plan 6 Alternative and the Preferred Plan was the inclusion of Solution Area A. This alternative has perhaps the best overall distribution of habitat types and would provide for 122.3 habitat units. Although Best Buy Plan 6 meets the target percentages, the incremental cost per HU in Best Buy Plan 6 is greater than Best Buy Plan 5. For this reason and because the cost of implementing this plan, given other costs (LERRD and Planning) would have exceeded the budget, Best Buy Plan 6 was rejected. Additionally, due to cost, the inclusion of Solution Area A would have eliminated the possibility of including interpretive and recreational features in the project, which are important to the sponsor. As stated previously, the Study Area is one of the most intensively used areas in the bosque, and there is opportunity through the proposed recreational features to 1) lessen the potential impact of recreation on the bosque in the Study Area and 2) to provide connections to a number of recreational amenities in adjacent areas which can support more active uses.

4.5.2 The Preferred Alternative

The Preferred Alternative is Best Buy Plan 5 combined with the proposed interpretive and recreational facilities. Best Buy Plan 5 meets the target percentages and even exceeds the overall target percentages for the three different habitat types, and through implementation would result in a dynamic mosaic in the Study Area. In total, implementation of Best Buy Plan 5 would result in the creation of 126.5 HUs in the restored bosque and allows for all of the objectives of the Study to be met. The overall budget for Best Buy Plan 5 would allow for much needed designated recreational and interpretive features which would reduce the overall impact of recreational users on the bosque as it is restored while still providing important connections to adjacent facilities. Implementation of the Preferred Alternative would maintain and enhance the function of the bosque in the Study Area as a wildlife refuge and integrate it into the fabric of the City Albuquerque’s portion of the Middle Rio Grande bosque.

Section 5 Description of the Recommended Plan

5.1 The Preferred Alternative

The Preferred Alternative is based on Best Buy Plan #5 generated by the Incremental Cost Analysis combined with the proposed recreational features. The Preferred Alternative is portrayed in **Figure 5.1**. A figure with updated background aerial photography is also provided in **Figure 5.2**. **Table 5.1** summarizes the ecosystem restoration features. The Preferred Alternative represents the most cost-effective aggregation of restoration features by Solution Area in the overall Study Area for the Route 66 Project. Through implementation of the Preferred Alternative, five out of eleven Solution Areas–totaling approximately 121 acres of bosque–would be restored by enhancing hydrologic function and restoring native vegetation. In addition, recreational use of the bosque would be improved by creating designated trails with benches, signs and other interpretive features.

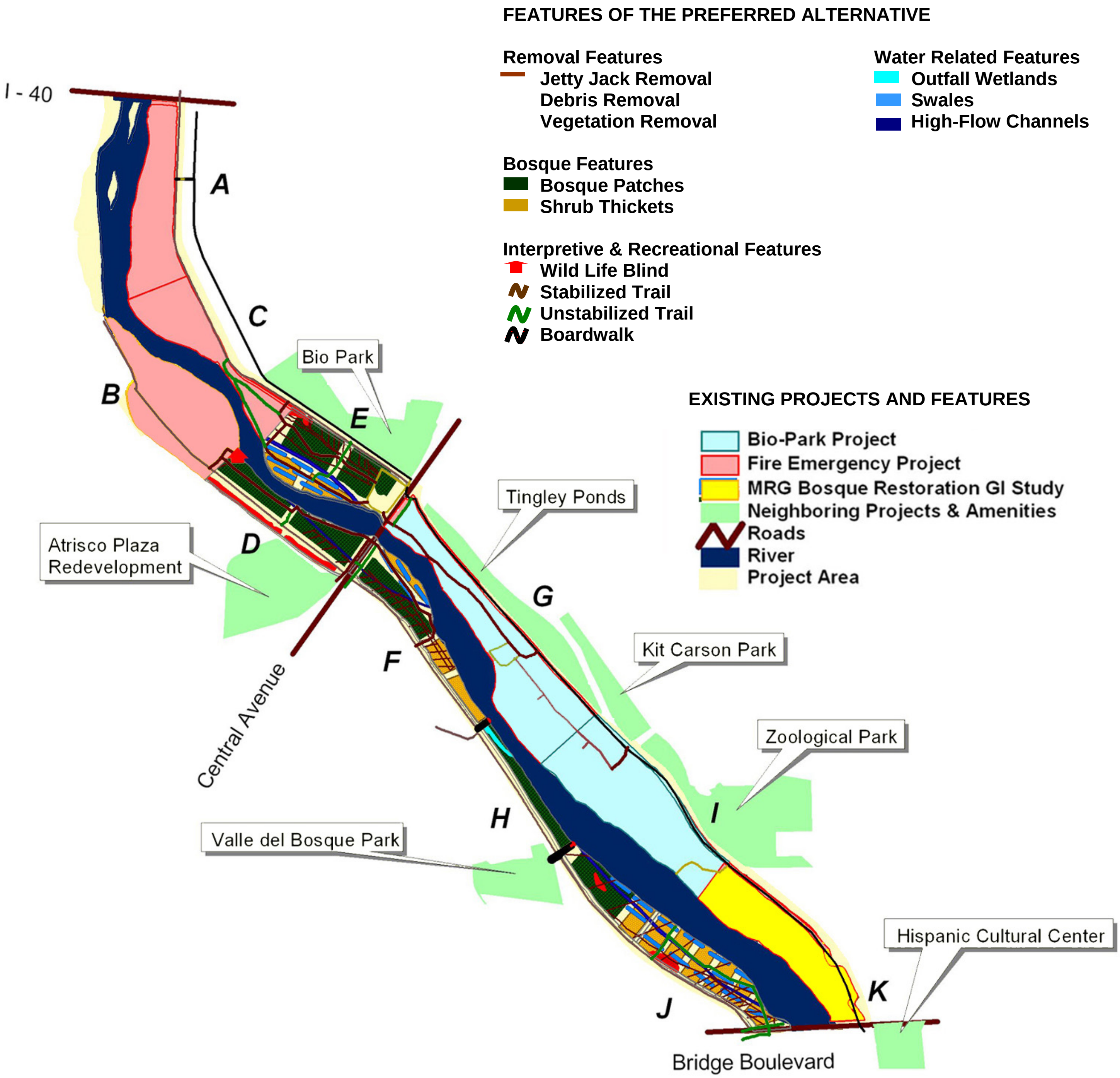


Figure 5.1 Preferred Alternative

Figure 5.2 Preferred Alternative (2006 Aerial Photography)

Table 5.1 Detailed Description of Preferred Alternative Features

Area Solution	Feature	Type	Quantity		Total HUs Created*	Water Feature HUs	Bosque Feature HUs	Shrub Feature HUs
D	1.4	Jetty Jack Removal	87	jetty jacks				
	3.3	Dump Removal	27,906	cubic yards				
	5.4	High-Flow Channel	0.92	acres	0.46			
	7.4	Bosque Patch	8.2	acres	8.2			
	7.5	Bosque Patch	9.61	acres	9.61			
	Totals				**18.27**	**0.46**	**17.81**	**0**
E	1.5	Jetty Jack Removal	278	jetty jacks				
	3.4	Dump Removal	23,477	cubic yards				
	5.5	High-Flow Channel	1.63	acres	1.63			
	6.5	Swales	4	acres	4			
	7.6	Bosque Patch	9.52	acres	9.52			
	7.7	Bosque Patch	8.37	acres	8.37			
	8.15	Shrub Thicket	3.39	acres	3.39			
	8.16	Shrub Thicket	3.17	acres	3.17			
	Totals				**30.08**	**5.63**	**17.89**	**6.56**
F	1.6	Jetty Jack Removal	287	jetty jacks				
	2.3	Vegetation Removal	24.75	acres				
	5.4	High-Flow Channel	0.92	acres	0.46			
	6.6	Swales	2.5	acres	2.5			
	7.8	Bosque Patch	8.98	acres	8.98			
	8.17	Shrub Thicket	3.25	acres	3.25			
	8.18	Shrub Thicket	3.1	acres	3.1			
	8.19	Shrub Thicket	3.05	acres	3.05			
	Totals				**21.34**	**2.96**	**8.98**	**9.4**
H	1.8	Jetty Jack Removal.	80	jetty jacks				
	2.5	Vegetation Removal	25.01	acres				
	3.6	Dump Removal	7,964	cubic yards				
	4.5	Outfall Channel	0.96	acres	0.96			
	5.6	High-Flow Channel	2.56	acres				
	6.9	Swales	1.5	acres	1.5			
	7.11	Bosque Patch	8.72	acres	8.72			
	7.12	Bosque Patch	9.59	acres	9.59			
	8.21	Shrub Thicket	3.31	acres	3.31			
	Totals				**24.08**	**2.46**	**18.31**	**3.31**
J	1.1	Jetty Jack Removal.	355	jetty jacks				
	2.7	Vegetation Removal	27.27	acres				
	3.8	Dump Removal	35,555	cubic yards				
	5.6	High-Flow Channel	2.56	acres	2.56			
	6.3	Swales	5.5	acres	5.5			
	8.23	Shrub Thicket	3.41	acres	3.41			
	8.24	Shrub Thicket	3.32	acres	3.32			
	8.25	Shrub Thicket	3.35	acres	3.35			
	8.26	Shrub Thicket	3.2	acres	3.2			
	8.27	Shrub Thicket	2.69	acres	2.69			
	8.28	Shrub Thicket	2.85	acres	2.85			
	Totals				**26.88**	**8.06**	**0**	**18.82**
	Total HUs: 120.65					**19.57**	**62.99**	**38.09**

* High-Channels that are shared between two Solution Areas are only counted once with respect to Cost and Habitat Units

In total, approximately 20 acres of water-related HUs (this includes High Flow Channel, Swale and Outfall Channel Habitat) would be created; 63 Bosque Patch HUs and 38 Shrub Thicket HUs are provided for by the Preferred Alternative. The overall acreage for the areas encompassed by the selected Solution Areas of the Preferred Alternative is approximately 121 acres. The remaining areas are meadow and savannah areas, some of which would be maintained in the form of firebreaks between the other features. A description of the features in more detail is below in Section 5.1.1 and Table 5.2.

5.1.1 Summary Description of Features

Table 5.2 Summary of Preferred Alternative Features

	Location	Dimension/#	# of Acres
Non-native vegetation removal			121*
Jetty jack removal		720	
Debris removal		95,000 yds^3	
Non-native vegetation treatment		103 acres	
Hi-flo channel	Central NW		2
	Central SW		2
	Bridge NW		2
Outfall Wetland			1
Willow Swale	Central SW	5	3
	Bridge NW	14	10
Revegetation			121

*Note: Non-native vegetation removal will take place first across all areas and then hi-flo channels, etc. will be constructed. Therefore, the overall acreage affected is still 121 but all features (hi-flo channels, outfall wetland and willow swales) will be constructed in the same areas where the non-native vegetation removal will take place first.

5.1.1.a Removal Features

Under the Preferred Alternative, approximately 95,000 cubic yards of debris are proposed for removal from Solution Areas D (see Figure 5.3), E, H and J. Removal of the debris would create new areas for native revegetation and would improve the aesthetic quality of the bosque. Some of the removed material may be recyclable as a base course for the proposed trails.


Figure 5.3 Debris within Solution Area D proposed for removal under the Preferred Alternative

The Preferred Alternative envisions the removal of approximately 1,087 non-functional jetty jacks from all five Solution Areas. Bank-line jacks and tie-back jacks in narrow bank areas in the Study Area, such as in Solution Area H, would not be removed. Removal of jetty jacks would improve access to the bosque for restoration and firefighting efforts. Removal of jetty jacks would also enhance the bosque's recreational function by improving aesthetic qualities. Vegetation removal would take place in Solution Areas F, H & J in the Preferred Alternative. More intensive removal operations are proposed for approximately 77 acres in total. All Solution Areas would be subject to treatment and removal of resprouts and seedlings of non-native vegetation.

5.1.1.b Water-Related Features

A single Outfall Channel, approximately an acre in size, is envisioned in the Preferred Alternative at the Sunset Irrigation Wasteway Outfall in Solution Area H. This Outfall Channel would function both as moist soil environment and as wet channel during irrigation overflow and clean-out events. It would provide a moist substrate for sedges, rushes, reeds and other moisture seeking plants and animals. Over time, coyote willow would likely form a thick stand along this feature. Design of the channels would be coordinated with final alignments of trails to limit access and create potential refuge areas on the riverside of the channels.

The Technical Appendix contains calculations performed by the Albuquerque District showing that with some connection improvement, hydraulic connectivity of the High-Flow Channels and the river overbank can be established. Improvements for connectivity would increase likelihood of flow, and subsequent water habitat at flows at or above 3,000 cfs.

The Preferred Alternative would involve the construction of three High-Flow Channels. One channel connects Solution Areas D and F. A second channel begins in Solution Area H and reconnects with the river in Solution Area J. A third channel is found in Solution Area E between the river bar in the low-flow channel and the older bosque area. Together, these channels constitute almost 6 acres of new habitat units. The High-Flow Channels are designed to re-create the historic braided channels of the river during high-flow events. Design of the channels would be coordinated with final alignments of trails to limit access and create potential refuge areas on the riverside of the channels.

Exact locations of the high-flow channels were modified based on input through the public and agency input process during the 30-day public review of this document (which was held March 19 through April 18, 2008). The high flow channel originally considered in Solution Area E was removed from the project since it has already been constructed by the New Mexico Interstate Stream Commission. The remaining high-flow channels on the west side of the river were altered somewhat and are described as follows:

Channel 1 - The northernmost channel is upstream of the Central Avenue Bridge in the left overbank and is approximately 1,400 feet long.

Channel 2 - The middle channel is downstream of the Central Avenue Bridge in the left overbank and is approximately 1,450 feet long.

Channel 3 - The southernmost channel is upstream of the Bridge Street Crossing in the left overbank and is approximately 3,350 feet long.

Channels 1 and 2 were originally proposed as one continuous channel beginning upstream of the Central Avenue Bridge and ending downstream of the Central Avenue Bridge. However, there currently exists an important USGS stream gage on the Rio Grande at the Central Avenue Bridge (USGS 08330000 Rio Grande at Albuquerque, NM). Some flow would have bypassed this gage with the originally proposed continuous high flow channel. Therefore, it was important to return all flow to the Rio Grande in channel 1 upstream of this stream gage and then flow could again be diverted in channel 2 downstream of this stream gage.

The Preferred Alternative calls for Swales in Solution Areas E, F, H and J. In total, these areas would create approximately 13 acres of moist soil environments. As with other water related features, these features would become ephemerally wet when ground water is high (spring run-off period and monsoon periods), but would be drier during times of low ground water (summer, fall and winter), enabling moisture-loving plants such as reeds, rushes and willows to thrive. On the edge of the depressions, thick stands of coyote willows, peach leaf willows, and other bosque endemic shrubs would develop with an occasional cottonwood, creating diversity in height and structure. In total, approximately 20 acres of new moist habitat would be created as part of the implementation of the Preferred Alternative.

5.1.1.c Bosque-Related Features

Approximately 63 acres of bosque forest in 7 patches, ranging from 8 to 10 acres in size, are envisioned in the Preferred Alternative. Firebreak meadows are to be maintained between these forest patches where they exist, as well as other bosque features. In these areas, efforts would be made to reconstitute the native understory of the bosque wooded areas, including mid-canopy trees and shrubs such as peach leaf willow, black willow, New Mexico locust and New Mexico olive, and lower canopy shrubs such as sumac, golden currant and *Amorpha*. Over time, the structure of these areas would be similar to Hink and Ohmart's classes I & III.

The Preferred Alternative provides for 12 Shrub Thicket patches, which add up to approximately 38 acres. Most of these are located on river bars and areas adjacent to the river and are intended to become denser stands of shrubs and small trees or under existing canopy. These patches would correspond to Hink and Ohmart's Structure Type V and over time, depending on the success of cottonwoods, could evolve into Structure Type III.

Included in the mix of plants would be peach leaf willow, black willow, New Mexico olive, chamisa, New Mexico locust, wolfberry, golden currant and sumac; and adjacent to the river and other wetter areas, seep willow and coyote willow. Grass meadows would be maintained between these patches to enhance the edge effect and keep the potential for catastrophic fire to a minimum.

5.1.1.d Recreation and Interpretive Features

A suite of recreation and interpretive features has been proposed (see **Section 4.2.4**) as part of the Preferred Alternative. Sensitive design and implementation of these features would be critically important to maintaining the success of the restoration features. In the process of restoring the Solution Areas in the Preferred Alternative, approximately 40,000 linear feet of undesignated trails would be replaced by approximately 6,700 linear feet of stabilized trails and 23,000 linear feet of soft-surface trails. Cumulatively, these trails, once built, maintained and policed, have the potential to significantly reduce the human impact on wildlife and vegetation in the bosque while increasing the functionality of the existing recreation system. Defined edges, distinct materials and signage would encourage users to remain on the trail system. These trails would enable the bosque in the Study Area to connect to the urban fabric of Albuquerque. One elevated boardwalk in Solution Area H. Doing so would provide a unique and improved recreational and interpretive experience to neighboring residents, the larger community and the many visitors to Albuquerque.

5.1.2 Implementation Process

The Preferred Alternative would be to treat areas for removal of non-native vegetative species, specifically salt cedar (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), Siberian elm (*Ulmus pumila*) and Tree of Heaven (*Ailanthus altissima*), and reduce fuels in areas of high fuel loads within the Study Area. Jetty jacks within the bosque also would be removed where they have been determined to be unnecessary. Work would take place between September and April of each year. No work within the bosque would take place during the nesting season (May 1- August 30) unless it was an open area and bird surveys were performed.

Access to all work areas would be along the levee. A staging area has been designated. The staging area is north of Central Avenue on the west side of the river where the MRGCD currently stores ditch clean-out spoils. Additional access and subsidiary staging areas to facilitate construction activities would need to be coordinated with MRGCD, AOSD, and the Bio-Park. No fueling would take place in the bosque.

Treatment Methods:

There are a number of methods for reducing fuel loads and treating non-native vegetation that have been and are being utilized in the Middle Rio Grande and throughout the Southwest. These methods include both manual and mechanical treatment methods, which are described below. Follow-up treatment with herbicides or root ripping are also options.

- Manual treatment - Using this method, dead material would be piled up and/or processed by cutting into smaller chunks using a chain saw. Large material would be hauled off, some for use as fire wood. Smaller material would be chipped using a chipper on site. Chips would either be tilled into the ground prior to revegetation or hauled off depending on the density. No more than 2 inches of chipped material would be left on site. The stump of any live non-native trees that is cut would be treated immediately with herbicide (if not ripped out by the roots – see Mechanical treatment below). This method would be used in areas where the bosque is not very wide and equipment would not fit or areas where there are a large number of native trees and shrubs to protect.

- Mechanical treatment - Mechanical control entails the removal of aerial portions of the tree (trunk and stems) by large machinery such as a tree shear or large mulching equipment. Both dead material and live non-native trees could be treated mechanically. This would leave the base of the tree exposed. The stump or tree could be ripped out mechanically if possible. Where possible, trees would be ripped out whole. Otherwise, the stump would be treated immediately with herbicide. Material would be processed as stated above – large material would be hauled off and smaller material would be chipped.

- Combination treatment - The most efficient methodology for treatment of dead material and non-native vegetation is usually a combination of manual treatment, mechanical treatment and use of herbicide. Some areas may be very thick and the use of manual methods allows them to be opened up for machinery access. Then mechanical equipment can take over while hand crews can move ahead of machinery to keep areas open enough to work in without damaging native vegetation to remain. The methodology to be implemented at each location would be evaluated on a site-by-site basis, and adaptively managed.

Treatment of Resprouting Non-native vegetation

Where AOSD contractors or crews have already worked, resprouting of non-native vegetation is occurring. These resprouts would be treated with either herbicide or by root-ripping prior to revegetating the area with native species. Also thinning and removal of non-native vegetation under this Preferred Alternative would include herbicide treatment in many locations. Herbicide application would be used where root ripping is not an option. Herbicide would be immediately applied to the base using a backpack sprayer, hand application with a brush, or other equipment that allows direct application. Options for herbicide include Arsenal® or Garlon®. Each of these herbicides is evaluated in Section 6.16 below.

Jetty jack removal is also proposed at the locations shown in **Figure 5.1**. Removal of the jetty jacks would be completed in conjunction with fuel reduction and thinning of non-native vegetation where not already complete in order to minimize disturbance. Where tieback lines are removed, new anchors would be installed to insure remaining bank lines would not migrate from their current position. Jetty jacks to be salvaged would be stockpiled on site during construction and removed prior to the completion of construction.

It has been determined by the Corps, MRGCD and USBOR that the jetty jacks identified for removal in this Preferred Alternative can be removed with a low impact based on the proposed revegetation.

Where identified, debris would be removed. If construction debris is encountered in other project areas, it would be removed. When feasible, material would be recycled. Much of the concrete that had been cleaned up along Tingley Drive by AOSD was recycled and the same procedures would be followed during this project. Otherwise, material would be hauled to the local dump.

Following non-native vegetation removal, jetty jack removal and/or debris removal, water features would be inserted into the bosque. Construction of all features would be during the low flow of the river (Fall and Winter). Features would be constructed within the bosque first and then connected to the river last in order to reduce sediment inputs in to the river. If flows are adjacent to the inlet/outlet of the water feature (for example the high flow channels), the flows within the river may need to be diverted with a port-a-dam or similar device. Excavated material generated by the construction of these features would be made available to the local managing agencies (MRGCD, USBOR and AOSD) for their use. Material would be hauled to local areas for use or stockpiled at their facilities for future use. Silt fence (without lead weights) would also be used when working adjacent to the bank of the river. Trucks hauling sediment away would be covered. All of these Best Management Practices (BMPs) would be employed throughout the project.

All areas worked in under the Route 66 Project would be seeded and the water-related features planted with appropriate plantings as described in Section 4: rushes, salt grass and willows. In areas where the overstory cottonwoods remained, understory bosque plants such as New Mexico olive and *Amorpha* would be planted. Willows, seep willows and native grasses would be planted in open areas. In conjunction with the planting, the final trails would be laid out and constructed, and other recreational and interpretive features would be installed into the restored landscape.

5.2 Operation and Maintenance Considerations

For most Corps civil works projects, the responsibility for Operations, Maintenance, Repair, Rebuild and Rehabilitate (OMRR&R) is assumed by the local Sponsor following construction of the project. Upon completion of construction, the Corps would complete an Operations and Maintenance manual for the project that would summarize all OMRR&R requirements. Currently, the annual costs for OMRR&R are estimated to be approximately $21,000. This amount includes the following:

1) Spraying and removal of resprouts and seedlings from non-native plants.
2) Replacement of native plants that fail to become established.
3) Maintenance of firebreak areas between Bosque Patches, Shrub Thickets, and the levee.
4) Maintenance of the water features (removal of sediment as it builds up in the features).

5.3 Monitoring and Adaptive Management

Due to the relatively recent emergence of restoration science and the inherent uncertainty in ecosystem restoration theory, planning and methods, success can vary based on a variety of technical and site-specific factors. Recognizing this uncertainty, it is prudent to allow for contingencies to address potential problems in meeting restoration goals that may arise during or after project implementation. Corps guidance recommends the local sponsor implement "adaptive management" techniques in projects with the potential for uncertainty in achieving restoration objectives. Post-project monitoring is a crucial requisite of the adaptive management process, as performance feedback may generate new insights on ecosystem response and provides a basis for determining the necessity or feasibility of subsequent design or operational modifications. Success should be measured by comparing post-project conditions to the restoration project objectives and pre-project conditions.

Monitoring provides the feedback needed to establish protocols and make adjustments where and when necessary to achieve the desired results. There is currently no project similar enough to serve as a model for this restoration. For this reason, monitoring would be essential to the success of not only the Route 66 Project, but other Corps studies as well. Therefore, baseline data would be collected so that results can be quantified and compared. Monitoring of project performance and success would be conducted for five consecutive years following the construction of restoration measures. Wetland and bosque monitoring would include vegetation mortality, wildlife and vegetation species, groundwater and other environmental indicators. The monitoring for the project would be mainly through the Bosque Environmental Project Monitoring Program (BEMP).

The project would make use of the framework and services of the following programs for the monitoring process. The following sites have been identified for monitoring sites:

- North Preserve, East side south of I-40 BEMP (this location was installed in 2005 in order to monitor this project)

- Atrisco Site (This site is monitored by the UNM Civil Engineering Department and data from the Natural Heritage New Mexico also exists for this location).
- Groundwater Monitoring by Corps - There are 6 groundwater monitoring wells within the Study Area that Corps has been monitoring since 2003 for depth to groundwater, temperature, conductivity, pH, and dissolved oxygen. One of these wells was recently automated (November 2005) with a data logger which takes groundwater level readings every 15 minutes.

Stakeholders and researchers from UNM in coordination with Corps would be largely responsible for the monitoring program. All data would be shared and necessary adjustments to restoration activities would be made by consensus. Two additional wells will be installed in 2008.

5.4 Real Estate Requirements

All of the real estate is located within the Middle Rio Grande Project facilities. The Middle Rio Grande Project facilities is co-managed by the BOR and MRGCD. After construction has been completed, MRGCD as the local sponsor, will take over management and maintenance of the project. The MRGCD is a state entity and adheres to normal real estate practice and laws. For the purposes of this real estate plan, the real estate would be treated as if it were available to the open market. This would be necessary for the crediting issues of this project. Real estate values would be compared to similar type lands and estates. Minimum land requirements for this project are described by ER 405 1-12 paragraph 12-9b(6). Required lands are held under standard estates. MRGCD has been a non-Federal sponsor on several past district projects and has expressed strong support for this project. All construction access to the sites is by public roadway. All contractor staging is to be within designated areas. Excess material would be removed to an appropriate commercial dump site, based on other recent projects (USACE 2004). The value of lands, easements, rights-of-way, relocations, and disposal/borrow areas (LERRD) for permanent easements is estimated at $87,000. The full Real Estate Plan can be found in the Technical Appendix.

5.5 Project Implementation Procedures and Schedule

Remaining actions necessary for the approval and implementation of this project are summarized below.

- The Detailed Project Report and the draft Project Cooperative Agreement (PCA) have been transmitted to the Division Engineer, South Pacific Division, Corps, for approval.
- The Draft Detailed Project Report (with changes based on comments from the Division Engineer) was sent out for a 30-day public review from March 19 through April 18, 2008. A public meeting was held on April 2, 2008.
- The Environmental Assessment and FONSI with public and agency comments incorporated would be signed by the District Engineer, Albuquerque District.
- The PCA would be signed by the Middle Rio Grande Conservancy District and the Federal Government.
- The CORPS and the MRGCD would complete the final project design and the construction contract specifications.
- The CORPS and the MRGCD would conduct pre-award activities. Among these activities would be issuing plans and specifications to interested contractors, soliciting construction bids, reviewing submitted bids, and obtaining required permits and certification.

- A contract would be awarded to build the project.

PCA execution and completion of plans and specification is scheduled for the summer of 2008. The construction contract is scheduled for award in September, 2008, and construction activities would be completed by spring 2010. Monitoring would continue for five years following construction.

5.6 Project Costs

The feasibility level cost estimate summary by project phase is shown in **Table 5.3**. This feasibility study was accomplished with Federal funding. The Total Project Cost includes the feasibility, plans and specifications, and implementation phases and is subject to cost-sharing as described in the Section 5.8 and shown in **Table 5.4**.

Table 5.3 Project Costs

Phase	Total Cost
Planning, Engineering and Design	$1,051,000
Lands and Damages (LERRD)	87,000
Fish and Wildlife Facilities	3,525,800
Recreation Facilities	260,80
Construction Management	359,500
TOTALS	**$ 5,284,100**

Notes:
1. Estimate as of spring 2008: Final LERRD is to be completed during final accounting
2. Implementation costs are based on 2008 dollars and include a contingency of 20 percent
3. The costs generated by the MCACES are higher than those listed in the Best Buy Plans in Section 4 due to rounding and inherent methodological differences between the ICA and the MCACES, and updating costs to 2008 dollars.

5.7 Cost-Sharing Requirements

The MRGCD requested the current proposed project and would serve as the local cost-sharing Sponsor of the project. The cost-sharing requirements and provisions would be formalized with the signing of a Project Cooperation Agreement (PCA) between the MRGCD and the Department of the Army following approval of this Detailed Project Report/Environmental Assessment. In the PCA, the Sponsor would agree to pay 25 percent of the total project cost, which includes the feasibility study, plans and specifications phase and implementation (construction). Recreational features would be cost-shared at 50 percent.

The basic criterion for non-Federal cost-sharing responsibilities for Section 1135 projects is to provide 25 percent of total project costs, as further specified below:

Unless assumed by Federal Government, provide all lands, easements, and rights-of-way, including those necessary for borrow and dredged or excavated material disposal, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation and maintenance of the Project.

Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project-related betterments, except for damages due to the fault or negligence of the United States or its contractors.

Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the Project to the extent and in such detail as will properly reflect total project costs and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 33 CFR 33.20.

Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

The total project cost is approximately $6,660,000 (Table 5.4). The cost-sharing provision of the Section 1135 program prohibits the Federal Government from spending more than $5,000,000 for any one project. Therefore, the cost-share amounts would be approximately $4,844,000 Federal and $1,816,000 non-Federal. The Feasibility and Plans and Specifications were covered 100% federal, but cost shared prior to construction. Numbers were rounded.

Table 5.4 Project Cost Share for the Preferred Alternative

Purpose	Total Non-Fed Share	Total Federal Share	Total Implementation Costs
Ecosystem Resto	$1,514,000	$4,542,000	$6,056,000
Recreation	$302,000	$302,000	$604,000
Total	$1,816,000	$4,844,000	$6,660,000

5.8 Consistency with Project Purpose

The construction and operation of the proposed Section 1135 project would be consistent with the authorized purposes and current operation of the Middle Rio Grande Flood Control Project, Corrales Levee Project, Albuquerque Levees, Jemez Canyon and Cochiti Dams. Activities proposed within the Route 66 Project would not raise the Base Flood Elevation (BFE) of the floodway either during or after the project is completed and do not result in a change in water surface, thus the proposed plan would not result in increased erosion of the existing levees. Features of the project would include removal of jetty jacks, but this would only be accomplished after an analysis has been completed which determines that the jetty jacks are no longer functioning properly. Additionally, the features of proposed project would not alter the extent or frequency of damaging discharges within or downstream from the project reach.

Section 6 Foreseeable Effects Of The Recommended Plan

The Preferred Alternative would conduct bosque revitalization actions in five of the Solution Areas, which total about 121 acres. The Preferred Alternative would treat approximately 121 acres with a combination of management measures. These management measures would include maintenance of past understory vegetation clearing, jetty jack removal, removal of debris, creation of high-flow channels and swales, and planting native riparian and wetland species.

6.1 Soils

During construction of the Proposed Action, care would be taken to minimize sediment erosion. Local soil disturbance permits would be required in locations where jetty jack Removal and other soil disturbance might take place.

All waste material would be disposed of properly at pre-approved or commercial disposal areas or landfills. Fuel, oil, hydraulic fluids and other similar substances would be appropriately stored away from the Rio Grande and must have a secondary containment system to prevent spills if the primary storage container leaks. All heavy equipment operating in or near river floodplain should carry an oil spill kit or spill blanket at all times. No refueling or staging shall occur in the bosque.

Initially, there would be minimal to medium levels of soil disturbance. Replanting the areas with native grasses and other vegetation would negate these short-term impacts. Overall, the increase of soil moisture in the floodplain is beneficial. Replenished soils may facilitate an increase in native vegetation and contribute to development of moist soil and wetland habitat. Additionally, any disturbed areas would be monitored by several involved agencies to insure stability of these affected areas and the BMPs listed above would be used. Any excavated materials from the construction of side channels would be recycled, used on site or hauled off to an approved disposal site as discussed above. Therefore, there would be a temporary short-term adverse effect to soils by the Preferred Alternative.

6.2 Hydrology, Hydraulics and Sediment Continuity Analysis

The Rio Grande channel bank is approximately 5 feet above the river bed through the Ecosystem Restoration @ Route 66 Project (Route 66 Project) site. This site "appears to be disconnected or less responsive to river flow. Water table depths as well as the lack of spatial and temporal variation in the water table indicate efforts to establish new cottonwoods by seed or pole planting will likely fail without periodic overbank flooding" (Eichhorst et al., 2001). Since the bank is approximately 5 feet above the river bed, bankfull flows of approximately 6000-7000 cubic feet per second (cfs) still would not provide overbank flooding at the site. This is supported by the Middle Rio Grande Bosque Feasibility Study results presented earlier as well as observations made during high flows in the spring of 2005. Therefore, a reconnection between the overbank area and the river is needed to provide flooding internal to the bosque. In this case, three high flow channels are proposed to do that. The proposed channels will have a bottom width of approximately 10 feet with 3 to 1 side slopes (3 horizontal to 1 vertical). The Route 66 Project also consists of six embayment areas. Three will be located at the upstream channel confluences and three will be located at the downstream channel confluences with the Rio Grande. These embayment areas are planned to be 140 feet wide and would be cut into the bank by approximately 70 feet. This will result in a total water surface area of approximately 1.35 Acres for all six embayments combined. These embayments will hold water whenever the Rio Grande is flowing at 500 cfs or greater. When the Rio Grande is flowing at less than 500 cfs it is assumed that these areas will be similar to sand bars. At the high point of each channel will be a grade control structure comprised of a one foot thick rip rap blanket 60 feet in length for the full width of the channel to maintain the design intent.

River water is proposed to move through the channels at depths which vary from 0.5' to 3' depending on the flow rate of the Rio Grande. The orthophotography shows that these channel locations in the overbank areas are lower than the existing bank and excavation of the bank would provide a connection. These channels will therefore overbank at a lower flow rate than the Rio Grande active channel and provide inundation and connectivity for the bosque at these locations. A representative post-Cochiti annual spring runoff hydrograph with a peak mean-daily flow of 3,770 cfs was used for evaluating restoration alternatives. The preliminary design is based on a flow rate in the Rio Grande of 3500 cfs which is representative of the flow rate taken from the average annual hydrograph that would be sustained for a minimum duration of 14 to 21 days. However, they could begin to flow when the Rio Grande discharge reaches 3,000 cfs. The water surface elevation (WSEL) in the Rio Grande for that flow rate (3500 cfs) was used as the basis for setting the invert elevation for the Route 66 Project channels. This allows for flow through the Route 66 Project Channels of approximately 10 cfs with velocities that vary between one (1) and two (2) fps. Under these conditions water depth in the Route 66 Project Channels would vary from one half (.5) to one (1) foot. Several trail crossings of the channel occur within the project area. These trail crossings will be accommodated using clear span bridges with hand rails that will provide safety to the public while allowing channel flows to pass unobstructed. The representative post-Cochiti annual spring runoff hydrograph and the HEC-RAS hydraulic model used to determine the WSEL in the Rio Grande was developed as part of the Rio Grande Bosque Feasibility Study as described above.

HEC-RAS Hydraulic Modeling Procedure and Results

The Middle Rio Grande Bosque Restoration Feasibility Study HEC-RAS model is based on the 2002 US Bureau of Reclamation Rio Grande Aggradation-Degradation Study Cross Sections (Range Lines).

The modeling reach is from Range Line 340 (North end of Corrales just below Rio Rancho Waste Water Treatment Plant) to Range Line 632 (Downstream of Interstate Highway 25 and upstream of AT&SF RR Crossing in Isleta Pueblo). The 2002 Cross Sections used are based on NAVD88 Datum and the cross sections taken through this reach were flown on 25 January 2002. The flow in the Rio Grande measured at the Albuquerque Gage on that date was 321 cfs. The bridges through this reach were either surveyed or verified from as-built drawings and converted to NAVD88 Datum. This model was then calibrated to water surface elevation surveys conducted during spring 2005 high flow data that was collected by Tetra Tech Inc. under contract to the Albuquerque District Corps. Additional flow measurements were made at various flow rates at four bridges over the Rio Grande to further aid in calibrating the model. These bridges were at Alameda Boulevard, Central Avenue, Bridge Street, and Rio Bravo Boulevard. Water surface elevations were taken upstream and downstream on each bridge at various flow rates. This model will be referred to as the Rio Grande HEC-RAS Model.

Additional HEC-RAS Models were developed for the Route 66 Project high-flow channels. The water surface elevations (WSEL) from the Rio Grande HEC-RAS Model were used to provide upstream and downstream WSEL control for the Route 66 Project HEC-RAS Models. The Route 66 Project high flow channels are shown on the project map located in the Appendix and described as follows:

North Channel - The northernmost channel is upstream of the Central Avenue Bridge in the left overbank and is approximately 1,300 feet long.

Middle Channel - The middle channel is downstream of the Central Avenue Bridge in the left overbank and is approximately 1,400 feet long.

South Channel - The southernmost channel is upstream of the Bridge Street Crossing in the left overbank and is approximately 2,900 feet long.

The north and middle channels were originally proposed as one continuous channel beginning upstream of the Central Avenue Bridge and ending downstream of the Central Avenue Bridge. However, there currently exists an important USGS stream gage on the Rio Grande at the Central Avenue Bridge (USGS 08330000 Rio Grande at Albuquerque, NM). Some flow would have bypassed this gage with the originally proposed continuous high flow channel. Therefore, it was important to return all flow to the Rio Grande from the North Channel upstream of this stream gage and then flow could again be diverted into the middle channel downstream of this stream gage.

All three channels were designed for a target design flow of 3,500 cfs in the Rio Grande. All three channel sections will have a bottom width of 10 feet with 3:1 side slopes. The resulting flow rates in the Route 66 Project channels are approximately 10 cfs with velocities that average one (1) fps. Under this condition water depths in the Route 66 Project channels will vary from one half (.5) to one (1) foot. All three channels were also evaluated at flows in the Rio Grande of 6,000 cfs (Rio Grande bank full flow) and 7,750 cfs (100 year regulated peak at Albuquerque). These flows were evaluated for the Route 66 Project channels to determine flow depths and/or channel overtopping. The results of these evaluations are summarized as follows:

Rio Grande Flow 3500cfs	Channel Flow	Flow Depth @ High Pt.	Average Velocity	Channel Overtopping
North Channel	10 cfs	.5 feet	1.0 fps	No
Middle Channel	10 cfs	.4 feet	1.5 fps	No
South Channel	10 cfs	.6 feet	1.0 fps	No

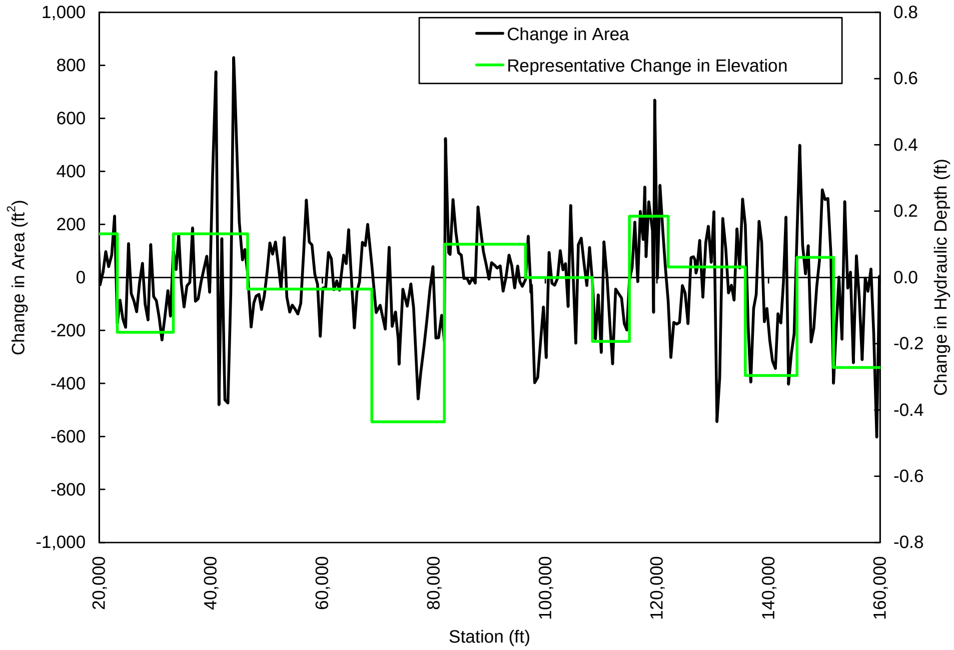
Rio Grande Flow 6000cfs	Channel Flow	Flow Depth @ High Pt.	Average Velocity	Channel Overtopping
North Channel	60 cfs	1.6 feet	2.0 fps	Yes
Middle Channel	80 cfs	1.4 feet	2.5 fps	Yes
South Channel	50 cfs	1.4 feet	1.7 fps	No

Rio Grande Flow 7500cfs	Channel Flow	Flow Depth @ High Pt.	Average Velocity	Channel Overtopping
North Channel	100 cfs	2.1 feet	2.5 fps	Yes
Middle Channel	130 cfs	1.7 feet	3.0 fps	Yes
South Channel	85 cfs	1.8 feet	2.0 fps	Yes

The HEC-RAS Models are included in Technical Appendix F. The Route 66 Project map is located in this Appendix showing the alignments for the high flow channels and their locations in relationship with the Rio Grande.

Geomorphology

To reflect future channel conditions in the project reach under the modeled alternatives, changes in the channel cross sections associated with aggradation/degradation 5, 20, 30 and 50 years after project implementation were



MEI

Figure 6.1. Predicted change in channel cross-sectional area at Year 5 and representative change in channel elevation.

estimated using a HEC-6T model of the reach that was previously developed by MEI for the New Mexico Interstate Stream Commission (NMISC) that extends the length of the project reach (MEI, 2007). The calibrated HEC-6T model was completed after the baseline conditions channel stability analysis (described in Chapter 2) was conducted. It was used to predict the amount of aggradation/degradation because it is considered a more appropriate model for predicting aggradation/degradation and because of its much shorter computation times compared to FLO-2D.

To facilitate the modeling, a 50-year mean-daily flow record was developed based on flow records at the Central Avenue Gage at Albuquerque for the post-Cochiti Dam period. Since the post-Cochiti Dam period of record includes only 30 years of (WY1974 to WY2004), the additional 20 years of data were developed by repeating the record for WY1985 to WY2004. This period was selected for the extended period because the average mean daily flow was very similar to the longer-term, post-Cochiti average mean daily flow (1,349 cfs for the period from WY1985-WY2004, versus 1,340 cfs for the entire 30-year period).

The HEC-6T model was run over the entire 50-year period, and cross-sectional geometry at 5, 20, 30, and 50 years was evaluated to determine aggradation/degradation changes throughout the reach. Because of the uncertainty in how each specific cross section will change as the aggradation or degradation occurs, the model results were used to estimate a representative change in cross-sectional depth within each segment of the reach that exhibits consistent aggradation/degradation trends based on the detailed model results. **Figures 6.1 and 6.2** show the predicted change in cross-sectional area from the model results and the assigned representative changes in channel depths for the 5- and 50-year conditions. The HEC-6T analysis indicates that both aggradational and degradational trends occur along the reach in Year 5. Over time, the aggradational areas shown in Year 5, change to stable or slightly degradational at Years 20 and 30, and there is a slight degradational trend along the entire project reach over the 50-year simulation. The manner in which the individual cross sections in the FLO-2D model were

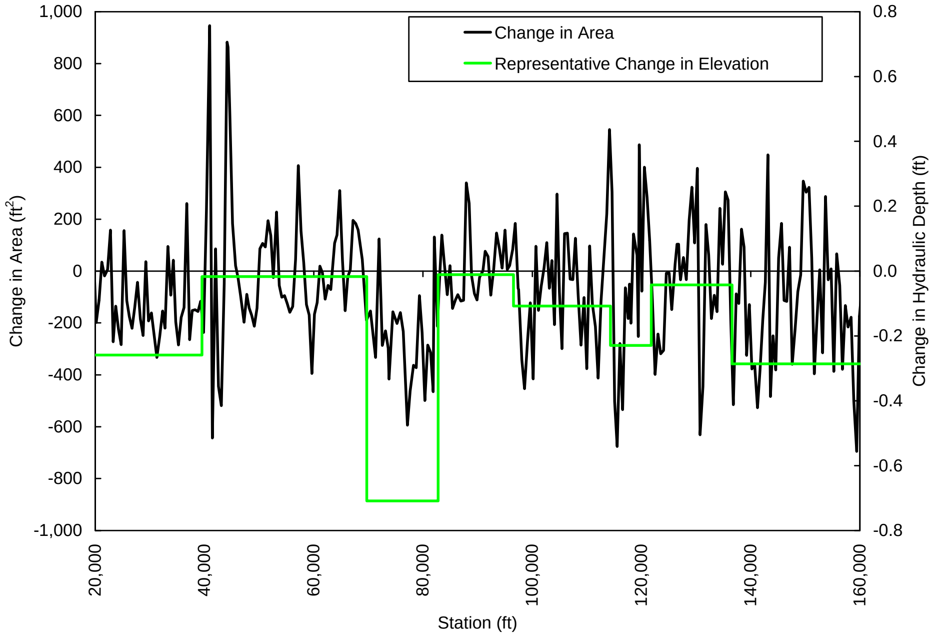


Figure 6.2. Predicted change in channel cross-sectional area at Year 50 and representative change in channel elevation.

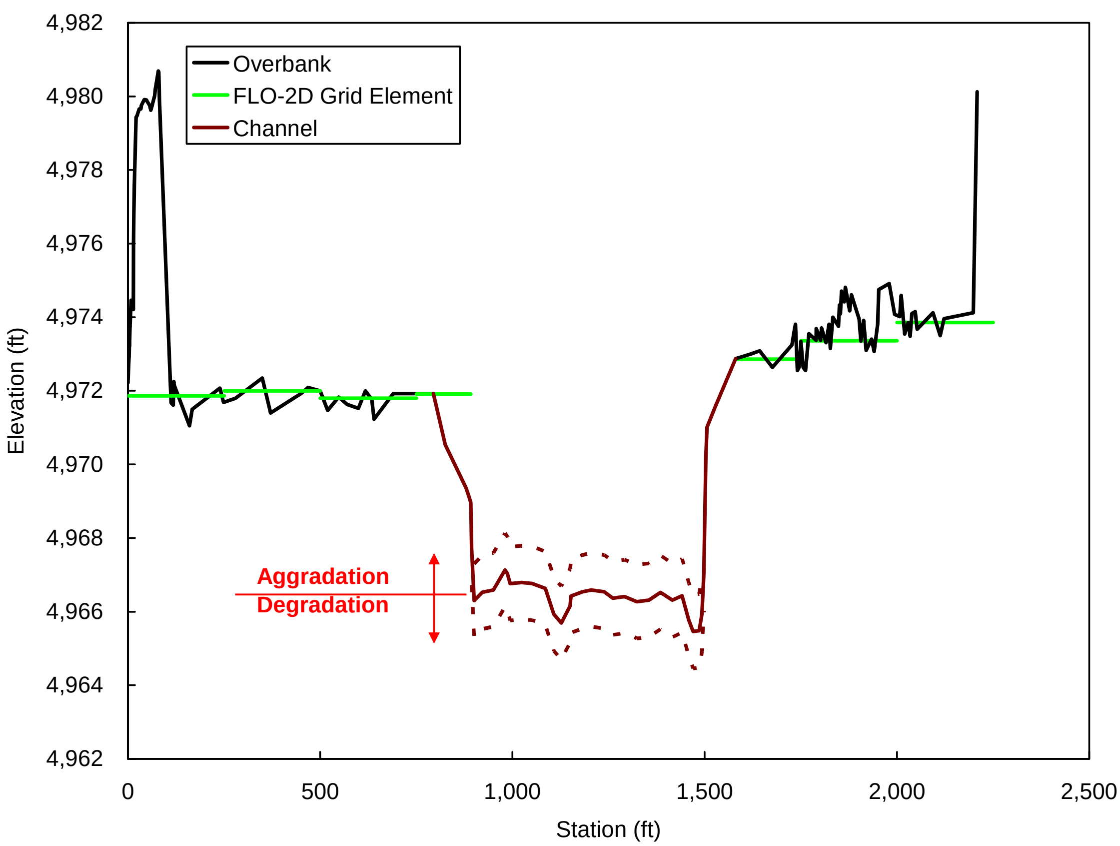


Figure 6.3. Schematic representation of development of the FLO-2D channel cross-sectional geometry for the 5-, 20-, 30-, and 50-year scenarios by applying the representative elevation change.

adjusted to the representative changes in channel depths for each of the indicated time-periods is illustrated in **Figure 6.3**.

Some Jetty Jack Removal is included in the Preferred Alternative. However, since no jacks would be removed from the bank lines, no geomorphologic changes are anticipated as a result of implementing this project. Initial analyses indicate that work within the floodplain would not have an adverse impact on the levees. Future analysis would be done during the pre-construction engineering and design phase to determine if there would be any impact on flood control facilities, which are anticipated to be negligible.

While there are some water-related features included in the Preferred Alternative, these features are passive in their use of water. The Outfall Channel in Solution Area H would only be used when the irrigation ditch is returning flows to the river. These flows would simply be rerouted through a channel prior to their discharge to the river. The Swales would only have standing water during periods of rainfall or during extended periods with high groundwater elevations. Water would only enter the High-Flow Channels during periods where the discharge is at, or near bank full. During low flows, river water would not be diverted from the low-flow channel. The overall area of water related features is relatively small. Based on these facts, there would likely be little or no negative effect on the hydrology of the Study Area as a result of implementing the Preferred Alternative. As discussed above, these areas were identified using HEC-RAS modeling and updated FLO-2D modeling for verification (Mussetter 2006). HEC-RAS drawings of proposed locations for High-Flow Channel and Swale habitat are shown in Technical Appendix F.

6.3 Water Quantity

It is estimated that the average annual water loss due to evapotranspiration (ET) in the Middle Rio Grande riparian corridor accounts for 20-50 percent of that reach's total water depletion (Dahm et al. 2002). Bosque ET appears to be higher in dense stands of salt cedar and in mature stands of cottonwood containing extensive understories of salt cedar and Russian olive than it is in less dense salt cedar stands and mature cottonwood stands with few understory trees (Dahm et al. 2002). Water evaporation was calculated specifically for the water related features (high-flow channels and the outfall wetland at the Gonzales Drain).

Calculation of Surface Water Evaporation

The project consists of three channels with a conservatively calculated combined length of 6,200 feet with an average top width at the design water surface of 20 feet. This results in a total design water surface area of approximately 2.9 Acres. These channels are designed to flow from 0.5 to 1 foot deep when the Rio Grande reaches a discharge rate of approximately 3,500 cfs. However, they could begin to flow when the Rio Grande discharge reaches 3,000 cfs. These channels are expected to flow on average from two to three weeks a year but for purposes of this calculation they will be assumed to flow thirty days per year. Since they will be flowing during the spring or early summer an evaporation rate of 0.23 inches/day will be used. The yearly evaporation calculated for the channels are as follows:

Evaporation = (2.9 Acres) x (0.23 inches/day) x (30 days) x (1 foot / 12 inches)

Yearly Evaporation for all three Channels combined = 1.7 Acre-Feet

The Project also consists of six embayment areas that will all be kept within the Interstate Stream Commission's designated 600 foot Rio Grande Corridor. Three will be located at the upstream channel confluences and three will be located at the downstream channel confluences with the Rio Grande. These embayment areas are planned to be 140 feet wide and would be cut into the bank by approximately 70 feet. This will result in a total water surface area of approximately 1.35 Acres for all six embayments combined. These embayments will hold water whenever the Rio Grande is flowing at 500 cfs or greater. When the Rio Grande is flowing at less than 500 cfs it is assumed that these areas will be similar to sand bars. To be conservative it will be assumed the Rio Grande flows at or above 500 cfs for ten months of the year. The evaporation rate applied to the embayments during ten months (304 days) will be 0.192 inches/day based on the average yearly evaporation of 70 inches in the Albuquerque area. The evaporation rate applied for the remaining two months (61 days) will be 0.0575 inches/day due to evaporation of water on sand bars*. The yearly evaporation calculated for the five embayments is as follows:

Evaporation (> 500 cfs) = (1.35 Acres) x (0.192 inches/day) x (304 days) x (1' / 12")
Evaporation (< 500 cfs) = (1.35 Acres) x (0.0575 inches/day) x (61 days) x (1' / 12")

Yearly Evaporation for all six Embayments = 7.0 Acre-Feet/Year

Lastly, the project also includes reactivation of the Gonzales Drain Wasteway to the Rio Grande. The return flow would be active during the irrigation season (typically late March to early October) or on average 180 days annually. The Gonzales Drain Wasteway within the Bosque that will be reactivated is approximately 850 feet long by 20 feet wide. This results in a total water surface area of approximately 0.4 Acres. Since it will be flowing during the spring and summer an evaporation rate of 0.23 inches/day will be used. The yearly evaporation calculated for the wasteway is as follows:

Evaporation = (0.4 Acres) x (0.23 inches/day) x (180 days) x (1 foot / 12 inches)

Yearly Evaporation for the Gonzales Drain Wasteway = 1.4 Acre-Feet

Total Project = 1.7 (Channels) + 7.0 (Embayments) + 1.4 (Wasteway) = 10.1 Ac-Ft.

Total Project Average Yearly Surface Water Evaporation = 10.1 Acre-Feet

Average Yearly Surface Water Evaporation within 600' corridor = 7.0 Acre-Feet

Average Yearly Surface Water Evaporation beyond 600' corridor = 3.1 Acre-Feet

*The evaporation rates for sand bars within shallow groundwater have never been synthesized for the Middle Rio Grande. However, the phreatophyte investigations at Bernardo (Bureau of Reclamation, 1997b), found that evaporation through a sandy soil with a ground water depth between 1 and 3 feet averaged 1.75 feet/year.

Taken from the "Final Environmental Assessment and Finding of No Significant Impact for Rio Grande Habitat Restoration Project, Los Lunas, New Mexico" dated March 2002 prepared by the US Army Corps of Engineers and the US Department of the Interior Bureau of Reclamation.

This evaporative water use for this project is being supplied by the NMISC via a Menorandum of Agreement (Appendix H). The NMISC has agreed to provide a maximum of 20 acre-feet per year for ten years.

6.4 Water Quality

Soil disturbance would result from Vegetation Clearing, Jetty Jack Removal, Debris Removal, and excavation of Swales and over-bank secondary channels (High-Flow Channels). Denuded soils would be susceptible to erosion by wind and water. This erosion could result in introduction of sediment to the Rio Grande. The potential for storm water pollution during construction is minimal for this project. A National Pollutant Discharge Elimination System permit would be obtained by the construction contractor.

Construction of the channel at the Sunset Outfall could reduce sediment and contamination loading to the Rio Grande from that source. The channel may act to filter and precipitate suspended sediments and associated contaminants. Temporary retention of surface water runoff in the channel may increase infiltration and transmission of surface water to shallow groundwater. Surface water may be filtered as it passes through the soil into the groundwater, which would improve water quality. Uptake of nutrients, metals, and other compounds by wetland plants in the Swales similarly may result in localized improvements in water quality.

Mechanical equipment such as brush-clearing machines and excavators could potentially leak oil, fuel, or hydraulic fluid, which could reach the Rio Grande and affect surface water quality. Spills of such materials could similarly contaminate surface water in the river or riverside drain. All equipment would be inspected daily to ensure that oil, fuel, hydraulic fluid, or other potential contaminants are not leaking out. All petroleum products would be stored outside of the 100-year floodplain and maintained to ensure that leaks or spills are contained and remediated at the storage site.

Section 404 of the CWA requires analysis of the EPA's 404 (b)(1) Guidelines if the Corps proposes to discharge fill material into a water or wetlands of the United States. A 404 (b)(1) Evaluation was performed for this project (Appendix E). The 404 (b)(1) analysis has been completed for Nationwide 33 and there would not be more than minimal impacts to the environment due to the proposed dredging. All conditions for the Nationwide 33 would be adhered to during construction. A water quality certification permit under Section 401 of the CWA would be required. The Corps would coordinate with the New Mexico Environment Department (NMED) regarding activities and schedules to allow the opportunity for monitoring water quality conditions during project implementation.

Section 402(p) of the CWA regulates point source discharges of pollutants into waters of the United States and specifies that storm water discharges associated with construction activity be conducted under National Pollutant Discharge Elimination System (NPDES) guidance. Some ground disturbance may take place. Therefore, an NPDES permit would be required. A Notice of Intent would be filed, and a Storm Water Pollution Prevention Plan (SWPPP) for the project would be developed by the contractor and be kept on file at the construction site and become part of the permanent project record. The Corps would obtain the NPDES permit prior to commencement of construction activities. Compliance with these requirements would ensure that the Preferred Alternative would have no significant effect on the water quality of the Rio Grande. Water quality would be monitored throughout the project. Silt fences (without lead weights) would be installed prior to construction in all areas and other standard BMPs would be implemented. All construction activities would be in compliance to all applicable Federal, state and local regulations. No adverse impact to water quality is anticipated.

However, some positive effects are likely to result from implementation of the Preferred Alternative. These could include improved water quality by designing the Outfall Channel to collect floatable trash and debris as well as the more traditional benefits that wetlands offer; e.g., sediment removal, increased biological activity which would promote improved water quality and reduced erosion.

6.5 Air Quality

Implementation of the proposed project would entail several actions that would result in an increase in particulate matter and release of other pollutants into the air. Approximately 121 acres of the Study Area would be worked in order to implement the Preferred Alternative. Actions that would result in soil disturbance that would increase particulate matter are: 1) driving vehicles and equipment on gravel or dirt levee roads; and 2) removing understory vegetation and jetty jacks in the soft, sandy soils of the bosque. The latter includes disturbance from vehicle tires and from the actions of Vegetation Clearing and grinding equipment. In addition, operation of equipment and vehicles to remove the jetty jacks and clear understory vegetation would contribute to emissions of various pollutants associated with vehicle exhaust (e.g. CO).

Topsoil disturbance and vehicle emissions would be temporary, lasting only until the project is complete. There would be no long-term increase in pollutants. Dust and vehicle emissions resulting from the Preferred Alternative would be similar in degree and intensity to the dust and emissions that are a result of on-going actions by the City, State Land Office, and other entities involved in understory Vegetation Clearing throughout the bosque beginning in the summer of 2003.

The proposed project is located in New Mexico's Air Quality Control Region No. 152, which encompasses all of Bernalillo County and most of Sandoval and Valencia counties. These three counties are "in attainment" (they do not exceed state or Federal Environmental Protection Agency air quality standards) for all criteria pollutants (NMED 1997). Air quality in the project area is generally good. The closest Class I area is Bandelier National Monument, approximately 50 miles to the north of the project area. A Class I area is a wilderness area or a National Park. Air quality in the project area is generally good to excellent due to the lack of urban industrial development. Although high winds are common in and around the project area, blowing dust is generally not a problem except during extremely dry years. All vehicles involved in transporting rubble and spoil from the project site to the deposition area would be required to have passed a current New Mexico emissions test and have required emission control equipment.

If the Preferred Alternative is implemented, the area of topsoil disturbance would be greater than 0.75 acres. As a result the Corps would obtain a fugitive dust permit from the City of Albuquerque and prepare a dust control plan. All work areas would continually be wet down to minimize dust. All vehicles hauling material would be covered during transport. These include covering trucks that remove material to avoid fugitive dust violations, maintaining and sweeping public trails to keep them free of debris and dust, and wetting down work areas. The 15 mph speed limit on levee roads which would also minimize dust, would be enforced. Therefore, short-term impacts to air quality are anticipated during construction but would be abated to the extent possible using BMPs as described above. Therefore the Preferred Alternative would be in compliance with all Federal, state and local requirements. There would be no long-term adverse effects to air quality by the Proposed Action.

6.6 Noise

The Occupational Safety and Health Administration (OSHA) noise standard limits noise levels to 90 dBA averaged over an eight-hour day (29 CFR 1910.95), although hearing damage can begin at levels as low as 80 dBA over an eight-hour day. No worker may be exposed to noise in excess of 115 dBA without protection, which would reduce the exposure below 115 dBA (AFSCME 2004).

Albuquerque's noise control ordinance was placed into effect in June 1975. The Environmental Health Department's Consumer Protection Division personnel are responsible for enforcing the ordinance. Noise control enforcement may involve many sources of excessive noise: radios, stereos, television, live bands, machinery, equipment fans, air conditioners, construction, vehicle repairs, motor vehicles, and general noise.

The ordinance stipulates a property-line value in which the noise level emitted must not exceed 50 decibels (dB) or 10 decibels above the ambient level, whichever is greater (Mitzelfelt 1996). For example, if you are playing a stereo, the sound level traveling from the stereo to the neighboring property lines cannot be more than 10 decibels higher than the general noise level existing before the stereo was turned on. Noise level meters are used to measure the sound level as it is crossing the property line. The meters are similar to radar meters the police use for speed detection; however, instead of detecting an object in motion, they detect air pressure (sound waves) in motion and produce a numbered level called decibels.

Implementation of the Preferred Alternative would entail several actions that would result in short-term increases in noise levels in the area. Actions that would directly create noise are: 1) driving vehicles and equipment on levee roads and 2) operating equipment to remove understory vegetation and jetty jacks and to construct project features (e.g., trails, over-bank channels, Swales).

Removal of Understory Vegetation, which acts as a buffer, would result in long-term increases in noise levels in the bosque. Removal of the understory could potentially remove this buffering effect permanently, unless dense understory vegetation is reestablished as is proposed by the Preferred Alternative.

This noise would still be somewhat abated in adjacent neighborhoods due to the buffering by the levee road when work is taking place in the bosque. Travel on the levee roads to and from work locations would also create noise during the project. The project would take place during normal work hours between 7:00 a.m. and 5:00 p.m. in order to minimize disturbance. All OSHA and local municipality requirements (as described above) would be followed. Therefore, there would be minor, short-term noise impacts by the Proposed Action during construction, which would occur only during normal working hours.

6.7 Ecological Resources

6.7.1 Plant Communities

The Preferred Alternative would result in substantial enhancement of native riparian vegetation and wet habitat in the Study Area, with concurrent reduction of nonnative stands. These effects are consistent with recognized measures for restoration and biological management of the bosque (Crawford et al. 1993).

Vegetation structure and species composition in the Study Area would be altered on about 121 acres, within Solution Areas D, E, F, H, and J (see Chapter 4). These Solution Areas, which comprise about 121 acres, have already been subject to clearing of non-native understory vegetation and woody debris as part of a fire-fuel reduction program conducted by the Albuquerque Open Space Division (AOSD), Ciudad SWCD or by Corps under the Bosque Wildfire Project (see Chapter 4 section 2, "Clearing and Removal of Non-native Vegetation). Most of the acres need retreatment though in some areas (for example, Solution Areas F, H, and J) much of the Siberian elm was left during the first treatment and would need an initial treatment (mechanical or manual as described in Section 5). It is proposed that during this project, much of the remaining Siberian elm would be removed. Selective non-native vegetation such as Russian olive and/or mulberry may be left in some areas.

The combined effect of proposed Non-native Plant Removal, Planting of Native Species, and Excavation of Channel, Outfall Channel, and Swale areas on vegetation structure and composition is summarized in **Table 6.1**. Stands currently dominated by non-native species would be changed to open areas or stands dominated by native species, namely cottonwood and coyote willow. The largest changes would be: 1) conversion of structure Type II stands to structure Type I stands with revegetation, 2) an increase in structure Type V stands dominated by coyote willow with Shrub Thicket treatments, and 3) a marked increase in herbaceous wet habitat from 1.13 acres to about 21.65 acres. Riparian areas would continue to comprise about half of the habitat in the composite Solution Area (**Table 6.1**). With respect to the entire Study Area, the Preferred Alternative would result in an overall increase in the diversity of vegetation communities.

Table 6.1 Estimated Change in Vegetation Structure with Implementation of the Preferred Alternative

Vegetation Structure	Existing Condition		Community Type[1]	Future Condition		Community Type[1]
	Acres	%		Acres	%	
I	0	0.00		9.85	8.16	C*
II	94.24	78.02	C, C/TW, C/MB	38.72	32.09	C*
III	4.83	3.99	C/LC	12.94	10.60	C*
IV	2.04	1.68	C/CW	28.09	23.28	C*
V	14.02	11.75	C, CW, RO	21.5	17.82	CW (Swale Habitat)
VI	0	0.00		1.05	1.00	Wet
Wet Habitat	0	0.00		8.5	7.05	Wet
Open	5.52	4.56	OP			
Total in Preferred Alternative	**120.65**	**100**		**120.65**	**100**	

[1]Community Types are codes as follows: C (cottonwood), RO (Russian olive), MB (mulberry), LC (locust), TW (tree willow), CW (coyote willow), OP (open areas) dominated by herbaceous plants
* C is existing at these locations, understory Bosque Patches and Shrub Thickets would be installed adding native species such as New Mexico olive, golden current, sumac, false indigo bush and wolfberry

This forecast of future conditions assumes that maintenance of the Study Area would prevent reestablishment of non-native-dominated stands and that Outfall Channel Habitat, High-Flow Channels, and Swales would develop and maintain a hydrologic connection between the river and bosque. The High-Flow Channels and Swales would likely result in propagation of native vegetation, which would help the area as well. During times of low flow, the channels would provide a moist soil area for plants, such as coyote willow, sedges, and rushes, and wildlife that prefer moister environments. Both functions are critical to improving the overall habitat in the reach (Crawford et al. 1993). Over the long term, the cottonwood-dominated structure Type IV stands would develop into later successional structure types.

The High Flow channel features could potentially restore some semblance of over-bank flooding in localized areas. This could promote establishment of early successional stands dominated by cottonwood and coyote willow. Such a process would likely create Structure Type V stands with stem density and species composition that cannot be achieved by manual planting. Also, localized lowering of the soil surface in Swales could subject some areas to fluctuating moisture regimes, which could restore naturally functioning wetland plant communities in those areas. However, fluvial geomorphic processes that create new sites for establishment of early succession wetland and shrub-sapling communities (Pittenger 2003: 4-8) would not be influenced by the Preferred Alternative.

As indicated above, individual locations within the proposed project would have varied revegetation strategies in order to achieve the target mosaic and stay within current water demands. Re-creation of the tiered bosque forest is important to sustaining a number of plants and animals in the bosque (Crawford et al. 1993, Hink and Ohmart 1984). These areas would become the patchy groves described in many of the early accounts of the river valley near Albuquerque (Scurlock, 1998). The larger size of these patches would provide important core habitat, while maintenance of the firebreaks would provide important edge habitat (Hink and Ohmart 1984). Edge effect and the creation of denser patches such as the proposed shrub thickets would be important increasing wildlife diversity within the bosque (Crawford et al. 1993, Hink and Ohmart 1984). Although, the Preferred Alternative may not be able to positively influence all the degradation processes at work in the bosque, replacement of dead material and non-native vegetation with a mosaic of native vegetation should lead to a system of less water use, decreased fire danger, and increased diversity of native species for use by wildlife. Therefore, the long-term effects of replacing the non-native dominated vegetation system with native dominated species is proposed to outweigh the short-term negative effects, which would be caused by the Preferred Alternative.

6.7.2 Fish and Wildlife

Creation of wet habitat in the Study Area from implementation of the Preferred Alternative would increase habitat available for wetland-dependent reptile and amphibian species such as tiger salamander, western chorus frog, bullfrog, northern leopard frog, Great Plains skink, New Mexico garter snake, western painted turtle, and spiny softshell turtle. An increase in the amount of moist, densely-vegetated habitats and coyote willow stands would also likely increase the abundance of small mammals. The amount of habitat for mammal species associated with wetlands in the bosque would expand. These species include western harvest mouse, plains harvest mouse, house mouse, tawny-bellied cotton rat, and New Mexico meadow jumping mouse.

While bird species richness may not initially increase in the Study Area as a result of the Preferred Alternative , bird abundance and the amount of habitat suitable for rare bird species would likely be increased. Once the shrub thicket stands reach maturity they will provide denser habitat preferred by bird species for foraging and nesting. Restoration of wetlands, cottonwood-willow, and cottonwood-New Mexico olive habitats would provide important habitat, particularly for neotropical migrant bird species that breed in the bosque (Thompson et al. 1994). Many neotropical migrant bird species in the western U.S. are declining and many of those species breed in riparian areas, which makes those habitats particularly important (Finch 1991). Restoration of early-successional willow thickets, in association with wetlands, could increase the amount of suitable habitat for Southwestern Willow Flycatcher and other bird species associated with wetlands and riparian shrub habitat.

The structure of late-successional stands (structure Types I and II) would be enhanced for timber-foliage foraging, timber-drilling, and timber-gleaning species that nest in the bosque such as Downy Woodpecker, White-breasted Nuthatch, Bewick's Wren, Northern Mockingbird, Solitary Vireo, Yellow Warbler, Yellow-breasted Chat, Summer Tanager, Western Tanager, Black-Headed Grosbeak, and Blue Grosbeak. Tanagers and vireos, in particular, may be declining in the bosque (Finch et al. 1995). Revegetated bosque sites can potentially provide avian habitat similar in quality to older cottonwood stands in as little as five years (Farley et al. 1994).

The emphasis in the Preferred Alternative on creating edge habitat and a fine-grained distribution of restoration features may facilitate brood parasitism by Brown-headed Cowbird. This is a major threat to many nesting bird species in the bosque, including the endangered Southwestern Willow Flycatcher (Finch et al. 1995, Schweitzer et al. 1998). Small passerine birds, such as Southwestern Willow Flycatcher, are particularly susceptible to the effects of brood parasitism. These birds depend upon high recruitment rates for population persistence. Clustering numerous small patches to create larger, contiguous habitats and reducing the number of edges adjacent to open areas where cowbirds forage could potentially offset this effect. Also, increasing revegetation of open areas to reduce their coverage in the Study Area would reduce cowbird foraging habitat.

Trails and recreational developments that would occur with implementation of the Preferred Alternative could have a negative impact on bird abundance and species richness in the Study Area (see Southwestern Willow Flycatcher Recovery Team 2002, Appendix M and references cited therein). Human presence and disturbance in the bosque reduces habitat quality for many bird species and in general results in lower species richness and bird abundance (Thompson et al. 1994). The Preferred Alternative includes about 22,500 linear feet of trail in the Study Area, in addition to benches, signs, one boardwalk, and a wildlife blind. Recreational uses of trails by hikers, bicyclists, and equestrians causes noise disturbance and usually results in waste accumulation (which may attract scavengers and predators). Additionally, trails create openings that may facilitate Brown-headed Cowbird parasitism, as described above. The frequency and intensity of recreational use associated with the proposed recreation features may further reduce habitat suitability for birds in the Study Area. However, the design, construction and maintenance of a limited number of formal trails would be preferable to the existing condition where numerous informal trails have been created and are used.

The proposed work would occur during the winter, which is when Bald Eagles may be in or near the Study Area. In order to minimize the potential for disturbing Bald Eagles utilizing adjacent habitat, the following guidelines would be employed. If a Bald Eagle is present within 0.25 mile upstream or downstream of the active construction site in the morning before activity starts, or is present following breaks in project activity, the contractor would be required to suspend all activity until the bird leaves of its own volition; or an Corps biologist, in consultation with the USFWS, would determine that the potential for harassment is minimal. However, if a Bald Eagle arrives during construction activities or if an eagle is greater than 0.25 mile away, construction need not be interrupted. Also, cottonwood snags or other large trees present along the riverbanks that may serve as potential roost habitat would be left intact as part of this project. Implementation of these measures would preserve undisturbed Bald Eagle use of roost, foraging and perching sites in the riparian area adjacent to the project sites.

The peak nesting season for birds is April through August. The Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703, et seq.) is the primary legislation in the United States established to conserve migratory birds (USFWS, 2004). The list of the species protected by the MBTA appears in title 50, section 10.13, of the Code of Federal Regulations (50 CFR 10.13). The MBTA prohibits taking, killing, or possessing of migratory birds unless permitted by regulations promulgated by the Secretary of the Interior. The U. S. Fish and Wildlife Service (USFWS) and the Department of Justice are the Federal agencies responsible for administering and enforcing the statute. In order to minimize potential effects on nesting birds in the project area, clearing of live vegetation would only occur between September and April.

Since the primary goal and effect of implementation of the Preferred Alternative is to revegetate with native species, which would create a healthier ecosystem in the long-term for native wildlife, these short-term effects (displacement, etc.) and impacts of limited recreational access would be outweighed by the long-term benefits. Therefore, the Preferred Alternative would have short-term negative affects on fish and wildlife with long-term positive benefits.

A Fish and Wildlife Coordination Act Report (CAR) was prepared by the U.S. Fish and Wildlife Service for this project (Appendix B). The following recommendations were provided by the Service to prevent and reduce adverse project effects on fish and wildlife resources during construction, operation, and maintenance of the proposed project:

1. Where possible, avoid construction during the migratory bird nesting season of March through August.

Where that is not possible, tree stands or other adequately vegetated areas slated for grubbing or clearing should be surveyed for the presence of nesting birds prior to construction. Avoid disturbing nesting areas until nesting is complete.

2. Employ silt curtains without lead weights, cofferdams, dikes, straw bales or other suitable erosion control measures during construction.

3. Store and dispense fuels, lubricants, hydraulic fluids, and other petrochemicals outside the 100-year floodplain. Inspect construction equipment daily for petrochemical leaks. Contain and remove any petrochemical spills and dispose of these materials at an approved upland site. Park construction equipment outside the 100-year floodplain during periods of inactivity.

4. Ensure equipment operators carry an oil spill kit or spill blanket at all times and are knowledgeable in the use of spill containment equipment. Develop a spill contingency plan prior to initiation of construction. Immediately notify the proper Federal and state authorities in the event of a spill.

5. All work and staging areas should be limited to the minimum amount required. Existing roads and right-of-ways and staging areas should be used to the greatest extent practicable to transport equipment and construction materials to the project site, and described in the Corps' project description. Provide designated areas for vehicle turn around and maneuvering to protect riparian areas from unnecessary damage.

6. Backfill with uncontaminated earth or alluvium suitable for re-vegetation with native plant species.

7. Scarify compacted soils or replace topsoil and revegetate all disturbed sites with suitable mixture of native grasses, forbs, and woody shrubs.

8. Protect mature cottonwood trees from damage during clearing of non-native species or other construction activities using fencing, or other appropriate materials.

9. Use local genetic stock wherever possible in the native plant species establishment throughout the riparian area.

10. Continue coordination of Rio Grande water management activities that develop and maintain riverine and terrestrial habitats by mimicking the typical natural hydrograph. An intergraded management of flows from upstream reservoirs should be pursued by the Corps for the purpose of protecting and enhancing the aquatic and terrestrial habitats along the Rio Grande.

11. Pursue and conduct floodplain management activities that discourage further development in the floodplain and address physical constraints to the higher flows that would be part of a natural hydrograph.

12. Explore expansion of the active floodplain of the Rio Grande at every opportunity.

13. Develop a coordinated program to monitor biological quality with emphasis on diversity and abundance of native species and ecosystem integrity with emphasis on restoring the functional connection between the river and the riparian zone of the Middle Rio Grande ecosystem.

14. Develop partnerships with local schools, universities, or other interested groups to help address post-

project monitoring and adaptive management needs (e.g., conduct periodic wildlife surveys, monitoring ecosystem response, etc.).

The above recommendations that can be incorporated during construction will be incorporated as BMPs. The Corps will coordinate with the Service on the more 'long-term' recommendations.

6.8 Special Status Species

Three agencies that have primary responsibility for the conservation of animal and plant species in New Mexico are the U.S. Fish and Wildlife Service (USFWS), under authority of the Endangered Species Act of 1973 (as amended); the New Mexico Department of Game and Fish, under the authority of the Wildlife Conservation Act of 1974; and the New Mexico Energy, Mineral and Natural Resources Department, under the authority of the New Mexico Endangered Plant Species Act and Rule No. NMFRCD 91-1. Each agency maintains a list of animal and or plant species that have been classified, or are candidates for classification, as endangered or threatened based on present status and potential threat to future survival and recruitment. Protection from harm, harassment, or destruction of habitat is afforded to species protected under the Federal Endangered Species Act. The New Mexico Wildlife Conservation Act and New Mexico Endangered Plant Species Act protect state-listed species by prohibiting take without a permit from the New Mexico Department of Game and Fish or New Mexico Forestry and Resources Conservation Division.

Foreseeable effects to nine of the species discussed in Section 2.8 that are known to potentially occur in the Study Area are discussed below. A Biological Assessment was submitted to the USFWS for their concurrence on the Rio Grande silvery minnow and the Southwestern Willow Flycatcher.. A Biological Opinion was received from the Service on July 10, 2008 (Appendix F).

- **Rio Grande Silvery Minnow** - Rio Grande silvery minnow occurs in the Rio Grande in the project area. Fish obtained from 2005 salvage operations conducted during river drying events and captive propagation have been stocked in the Albuquerque area in an attempt to restore the population in that reach (J. Brooks, personal communication). Releases of captive-reared Rio Grande silvery minnow have been made at Alameda Bridge, north of the project area.

Designated critical habitat for the species (68 Federal Register 8087: 8135) encompasses nearly the entire project area. Work would not take place in the main channel but it would take place along the bank when opening the hi-flo channels and it may result in erosion or other inputs into the river. When work is to occur close to the bank of the river, Best Management Practices listed under the Environmental Commitments section would be enforced to help prevent erosional inputs into the river. Additionally, this project is being constructed partially to provide potential habitat for the silvery minnow and would create additional nursery habitat in this reach which would help with the population.

Silvery minnows are present in the Albuquerque Reach (Dudley et al. 2006) and are expected to be present within the action area. The primary adverse effects of the proposed action on the silvery minnow would result from the potential placement of coffer dams or silt curtains around the channel openings (if needed) and the mobilization of sediment when opening the channels. The proposed action may affect the silvery minnow and it's critical habitat– directly, indirectly and beneficially as described below.

Direct Effects
The proposed action is likely to have direct short-term adverse effects on silvery minnows during final construction activities involved in creating the north and south embayments of each hi-flo channel.

Silvery minnows may be disturbed as the coffer dam or silt curtain is installed (if needed). The silt curtain or coffer dam would be placed along the bank line and then pushed out into the channel to expand the bankline, under the supervision of Corps' Biologists. However, this form of disturbance would be minimal, short in duration, and the curtain/dam would exclude fish from contact with construction equipment and minimize mobilization of sediments. Construction at the channel openings would be monitored for minnows throughout construction. If silvery minnows were trapped in the project area, work would cease until the fish leave of their own volition, or a Corps' biologist, in consultation with the USFWS, determines that the potential for harassment is minimal. Findings of trapped, injured or dead silvery minnows would be reported to USFWS.

Occasional adverse effects are still likely beyond the construction period. High flows may deposit sediment in or at the openings of constructed channels so that isolated pools containing silvery minnows would be formed. Silvery minnows may become stranded in these isolated pools and die.

Indirect Effects
Sediment disturbance may result in indirect effects to the silvery minnow such as decreases in primary production associated with increases in sedimentation and turbidity which potentially produce negative cascading effects through depleted food availability to zooplankton, insects, mollusks, and fish. Water quality measurements would be taken before, during and after construction activity.

Beneficial Effects
The proposed action is expected to establish diverse mesohabitats that support the silvery minnow. Such habitat benefits the species through improved egg and larval retention, increased recruitment rates, and increased survival of both YOY and adult minnows. In the long term, the project is anticipated to have a beneficial effect on the silvery minnow and its habitat, contributing to the improvement of the status of silvery minnow into the future.

Based on the potential effects described above the Corps has determined that the proposed action may affect and is likely to adversely affect the endangered silvery minnow during construction. The following environmental commitments would be followed during construction:

1) Silt fence (without lead weights) would be installed adjacent to the riverbank to prevent erosion to the river.

2) Fueling of vehicles would not take place in the bosque.

3) Cleaning of all equipment is required prior to entering the site.

4) A Corps' biologist would monitor the project during construction at the bank of the river in order to detect any potential silvery minnow in the area. Findings of injured or dead silvery minnows would be reported to the Service. Water quality measurements would be taken before, during and after construction activity.

5) In coordination with the Service, a protocol to monitor presence/absence of silvery minnows in the channels following high flows, and to determine whether channel maintenance is warranted, would be developed.

6) Construction activities would take place in designated areas only, avoiding any unnecessary damage to the riparian area.

7) Work inside of the bosque would not occur between May 1 and August 30. Surveys would be conducted for the presence/absence of Southwestern Willow Flycatchers during their breeding season throughout the project area immediately prior to construction. If such surveys indicate breeding season occupation in areas not considered in this BA, the avoidance procedures outlined above would be applied to newly discovered areas.

In their Biological Opinion dated July 10, 2008 (Appendix F), the Service concurred with the Corps' effects statement, and stated that the project 'is not likely to jeopardize the continued existence of the silvery minnow.' They included the additional conservation measures and two additional Reasonable and Prudent Measures (RPM's) in their take statement for the Rio Grande silvery minnow:

1. Report to the Service, water quality measurements taken before, during and after construction activity.
2. Schedule, to the extent possible, embayment construction during dry or frozen soil conditions.

The Corps will comply with these RPM's and other measures discussed in the Biological Opinion (Appendix F).

Silvery Minnow Critical Habitat

The proposed action is likely to have a positive long-term impact on three of the four primary constituent elements of critical habitat for the silvery minnow. These include backwaters, shallow side channels, pools, and runs of varying depth and velocity; substrates of primarily sand and silt; and the presence of eddies created by debris piles, pools or backwaters, or other refuge habitat within un-impounded stretches of flowing water of sufficient length (i.e., river miles) that provide a variation of habitats with a wide range of depth and velocities. The proposed restoration project will create backwater embayments, and side channels that will inundate at higher flows. These habitats provide critical nursery habitat for silvery minnow eggs and larvae and enhance opportunities for silvery minnow recruitment. Short-term habitat disturbance will occur during the construction phase of this project. However, these effects will be limited in area and duration.

Reconnection of the high flow channels would occur during the winter, when river flows are at a minimum. The Corps would monitor the location for minnow and coordinate with the Service on whether Rio Grande silvery minnow should be transported away from the project area if they are detected. Therefore, the proposed action may affect but is not likely to adversely affect designated Critical Habitat of the Rio Grande silvery minnow.

The proposed project would provide benefits to the silvery minnow with the planned reintroduction of flow into 6 acres of high flow channel. The increased frequency of inundation would provide shallow, low-velocity aquatic habitat suitable for silvery minnow foraging and rearing areas.

The Service concurred with this determination and stated that 'the proposed action is likely to have a positive long-term impact' on three of the four primary constituent elements of critical habitat for the silvery minnow' (Appendix F).

- **Flathead Chub** - Work would not take place in the channel but would connect to the channel through the construction of High-Flow Channels as proposed in all locations. BMPs as stated above would be incorporated in order to minimize potential effects to the river area that may be utilized by the Flathead Chub. Therefore, the Preferred Alternative may affect but is not likely to adversely affect the Flathead Chub.

- **Yellow-Billed Cuckoo** - Habitat potentially suitable for nesting of Yellow-Billed Cuckoo is present in the Study Area, primarily in the form of dense salt cedar stands. Yellow-Billed Cuckoo has been noted to nest late into October (D. Krueper, personal communication 2003). Surveys for nests in potential habitat would occur through October prior to construction. This habitat would be thinned and revegetated during this project, creating potentially suitable native habitat in the future. Therefore, the Preferred Alternative may affect but is not likely to adversely affect the Yellow-Billed Cuckoo.

- **Southwestern Willow Flycatcher** - Willow Flycatcher surveys were conducted within the Study Area in 2002 and 2003 and did not find any migratory or nesting Southwestern Willow Flycatcher in the Study Area. During the 2004 and 2005 survey seasons, Southwestern Willow Flycatcher (*Empidonax traillii* extimus) were detected within the Study Area along the Tingley Bar on 27 May 2004, and 30 May 2005. Single individuals responded to the tape play-back at two locations within the site in 2004 and one individual responded to the tape play-back from an island in 2005. The individuals observed in 2004 were heard and observed singing in a clump of salt cedar along the river bank, and the second individual was heard singing in a dense clump of tall coyote willow on the river bar, about 150 feet from the edge of the river. In 2005, the individual was heard and observed in a stand of Russian olive on an island bar. It is presumed that these individuals were migrants. Much of this habitat that was being utilized by these migrants has been removed by an island destabilization project conducted by the New Mexico Interstate Stream Commission through the Middle Rio Grande Endangered Species Collaborative Program to benefit the Rio Grande silvery minnow.

  Based on these surveys and the fact that much of this potential habitat was removed, it is highly unlikely that nesting Southwestern Willow Flycatcher will occupy the Study Area during the construction proposed to begin in September 2008. It is very possible that migrants would be detected as they were along the Tingley Bar during the 2005 survey period. Surveys would take place again in 2008. If nesting Flycatchers are detected then consultation with USFWS would be reinitiated. Any nesting territories discovered would be avoided.

  As stated above, no breeding habitat has been identified during protocol surveys. Other projects in the area, such as the Albuquerque Biological Park Wetland Restoration Project, have created additional potential habitat for the flycatcher. This project would also create habitat that would potentially benefit the Southwestern Willow Flycatcher.

  The Corps has determined that the proposed work may affect but is not likely to adversely affect, the Southwestern Willow Flycatcher. Designated Critical Habitat was determined for flycatcher in November 2005 but is not in the project area. There would be a net beneficial effect with project implementation through increasing the suitability of or otherwise protecting Willow Flycatcher potentially suitable habitat.

  In their Biological Opinion, the Service concurred with the Corps' determination.

- **Yuma Myotis** - Since no work would take place in their potential habitat (namely under bridges), but the project may affect food sources, the Preferred Alternative may affect but is not likely to adversely affect the Yuma Myotis.

- **Occult Little Brown Bat** - Since no work would take place in their potential habitat (namely under bridges), but the project may affect food sources, the Preferred Alternative may affect but is not likely to adversely affect the Occult Little Brown Bat.

- **Pecos River Muskrat** - Since the Preferred Alternative would not affect existing wetland habitat it is unlikely that this species would be disturbed by the project. Therefore, the Preferred Alternative would not affect the Pecos River muskrat.

- **New Mexico Meadow Jumping Mouse** - The Preferred Alternative would not impact existing wetland habitat but may provide potential habitat for use by the New Mexico meadow jumping mouse. Therefore, the Preferred Alternative may have a beneficial effect on the New Mexico meadow jumping mouse. The U.S. Fish and Wildlife Service has concurred with this determination (Appendix G).

Some of the management solutions in the Preferred Alternative may partially fulfill requirements of the "Biological and Conference Opinions on the Effects of Actions Associated with the Programmatic Biological Assessment of the Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico," (March 2003) for both the Rio Grande silvery minnow and the Southwestern Willow Flycatcher.

6.9 Cultural Resources

A cultural resource records search of existing archaeological records and data, and archaeological surveys have been completed for the Route 66 Project. The Study Area is primarily confined to the bosque within the flood control levees and historic floodplain of the Rio Grande. Survey work included the entire bosque from the inside edge of the levees to the edge of the active river channel covering approximately 273 acres (Marshall 2003). Additional archaeological surveys covered a small 11.0 acre area located adjacent to the bosque but outside of the flood control levee (Everhart 2008a) and a 0.7 acre area located on and adjacent to the flood control levee and the Atrisco Lateral (Everhart 2008b).

The records search and archaeological investigations located three former bridge remnants (LA139208, LA138856 and LA138857); a probable irrigation diversion work (LA138858); abandoned segments of Atrisco and Ranchos de Atrisco irrigation canals (acequias; LA138859); a flood control construction (LA138855); and the abandoned MRGCD Atrisco diversion works (LA138860) (Marshall 2003). An abandoned segment of the Atrisco Riverside Drain was also recorded (LA159913) (Everhart 2008a) as well as a historic structure, a 1955 concrete box culvert identified as the Atrisco Lateral Wasteway (Everhart 2008b).

A number of isolated occurrences were also identified in the Study Area that included fill and dump debris in the bosque and along the edges of the flood control levees, homeless camps, and temporary shelters. All of the bridge remnants and the possible diversion works were identified on the immediate west bank of the active river channel with extensions into the actual river. They all include posts driven into the riverbed for bridge supports and diversion works. These structures are within the river channel and on the bank of the low water river channel, and should not be affected by the removal of fuel wood or brush and trees in the bosque. However, it is recommended that each of the structures be identified in the field prior to the project to insure that they are not affected.

A set of old wood pilings, documented as the Atrisco Irrigation Diversion Works (LA138858) and now abandoned, are a pre-MRGCD structure used to help move river water toward the river bank, and the pre-MRGCD abandoned segments of Atrisco and Ranchos de Atrisco irrigation acequias (LA138859) are both historic structures located in and immediately adjacent the bosque project area on the west side of the river, north of the Central Avenue bridge. The old wood pilings represent a late 19th to early 20th century engineering irrigation feature. The old wood pilings in the river channel will be avoided during the project. The Atrisco and Ranchos de Atrisco irrigation canals may date as early as the mid 17^{th} century. They were used until the early 1930s when construction of the MRGCD system reorganized irrigation works in the valley. These canals are located in a bosque project area where construction of a high- flow channel and additional vegetation removal are planned. Concurrence with the State Historic Preservation Officer has been reached and the work will result in no adverse effect to the historic canals (Consultation No. 084449; Appendix C). During the project, disturbance to the Atrisco acequia remnants will be minimized and avoided to the extent possible. The historic abandoned segment of the Atrisco Riverside Drain would be avoided during debris removal and therefore would no be affected (Consultation No. 084750) and the rehabilitation of the historic Atrisco Lateral Wasteway structure would have no effect to the historic MRGCD irrigation and drainage system (Consultation No. 085054).

It is recommended that all of the seven cultural resources identified in the project area should be avoided during the project. The sites should be identified in the field and marked prior to implementation of the project. These locations should be recognized as archaeological protected areas and the field crews should be instructed to avoid the locations. Given this treatment, the bosque restoration project would have no effect to the historic cultural resources noted above and there will be no adverse effect to the Atrisco and Ranchos de Atrisco irrigation acequias nor to the Atrisco Lateral Wasteway box culvert.

There are no historic properties listed on the New Mexico State Register of Cultural Properties or the National Register of Historic Places within the Study Area. There are numerous historic properties listed on the State and National registers in the nearby Albuquerque area, but none would be affected by the proposed undertaking. No traditional cultural properties or sacred sites are known to occur within the Study Area. The Corps has conducted informal consultation with Tribes with concerns in Bernalillo County. These include the Hopi Tribe, Isleta Pueblo, Laguna Pueblo, the Navajo Nation, Ohkay Owingeh Pueblo, Sandia Pueblo, the White Mountain Apache, Ysleta del Sur Pueblo, and the Jicarrilla Apache Nation. These Tribes were sent public scoping letters; responses were received from Isleta Pueblo and the Navajo Nation, both indicating that they had no concerns in regard to the project. No Tribal concerns have been brought to the attention of the Corps (Appendix C).

6.10 Socioeconomic and Environmental Justice

6.10.1 Socioeconomic Environment

The Preferred Alternative would benefit the socioeconomic environment of the City of Albuquerque area adjacent to the Study Area. Potential effects would be associated with construction of the proposed project. Construction effects would include beneficial effects associated with localized purchases of material, equipment and supplies and the effects of additional worker salaries and income. In the immediate area, local revenue benefits would largely be limited to a demand for goods and services. Increased recreational and interpretive opportunities may lead to more business for local merchants and other public institutions. The improvements to the Study Area in tandem with the existing public institutions would help the area become an even greater destination for tourists.

6.10.2 Environmental Justice

No displacement, relocation, economic, or any other type or disproportionate effect to minority or low-income populations of the community would occur under the Preferred Alternative. Improvements to the Study Area, including Dump and Debris Removal, storm water outfall mitigation and the addition of recreational and interpretive elements are likely to enhance environmental quality and quality of life for neighboring residents. In addition, the removal of dead, down and non-native vegetation would reduce potential fire danger to neighboring residents.

The project would not disrupt or displace any residential or commercial structures. The work has been reviewed for compliance with Executive Order 12898 and it has been determined that the Preferred Alternative would not adversely affect the health or environment of minority or low-income populations.

6.11 Land Use

There are no effects to current land uses in the Study Area as a result of the Preferred Alternative. No changes to land use designations would be made as a result of the Preferred Alternative

Outside the Study Area, especially on the west side, the improvements in the Study Area may result in the area being more desirable for residential living and commercial development. Such an impact could lead to redevelopment of vacant land into commercial enterprises and residential housing.

6.12 Recreational and Interpretive Resources

Recreational use, such as walking, biking, hiking, and jogging may increase with the proposed project (see Section 4.7). Recreational features within the restored area would include over 13,900 linear feet of ADA-accessible trails, additional soft surface trails of 8,600 linear feet, a pedestrian bridge, one boardwalk, a wildlife blind, educational signs, benches, and garbage cans. The trail system would traverse the area of the Preferred Alternative, as well as link to other trails outside the area. Educational signs would inform observers of the ecological function and importance of each plant community and water-related area. Other aspects of the Preferred Alternative would improve safety for recreational users, with better trails and the removal of the non-native understory in many areas.

Construction activities would temporarily impede recreational activities in the Study Area. All work zones would be designated and signed with cautionary information. The paved trail would be kept clean for use by park visitors as much as possible and all machinery and vehicles would yield to park users. Implementation of the Preferred Alternative would result in a considerable enhancement of the recreation system in the Study Area. The Preferred Alternative also conforms to and builds upon AOSD plans for the recreational system in the RGVSP.

Cumulatively these trails, once built, maintained and policed, have the potential to significantly reduce the human impact on wildlife and vegetation in the bosque, while increasing the functionality of the existing recreation system. These trails would enable the bosque in the Study Area to connect to the urban fabric of Albuquerque, as well as other recreational areas that can support more intensive recreational uses. The trail system would also integrate significant existing features such as the Atrisco diversion and the Bio-Park Project wetlands, as well as proposed new amenities including a wildlife blind in Solution Area D, one elevated canopy level boardwalk in Solution Area H and a series of benches throughout the system. In so doing, a unique and improved recreational and interpretive experience would be provided to neighboring residents, the larger community and the many visitors to Albuquerque. Therefore, the Preferred Alternative would have short-term negative effects on recreational and interpretive resources with long-term positive benefits.

6.13 Hazardous, Toxic, and Radiological Waste

Where noted and otherwise in existence within the project areas stockpiled sediment, concrete, asphalt and other construction debris would be removed as part of the Preferred Alternative.

The Material Safety Data Sheets for the herbicides presented in Section 6.16 have been reviewed and no lasting toxicological or detrimental ecological effects from the use of these products are known. These herbicides would be applied according to the manufacturer's instructions. When used in the manner intended and per manufacturers instructions the herbicide application area is not considered a contaminated or waste area. Excess herbicide would be disposed in accordance with all Federal, State, and Local regulations.

6.14 Aesthetics

In order to accomplish the goals of the project, construction within the bosque would include machinery of varying sizes. This would cause short-term negative affects to aesthetics during construction. Post-construction, some visual effects would be noticed. The new high-flow channels would be in place and much of the area would have new tree and shrub plantings. Therefore, there would be negative, short-term impacts by the Proposed Action to aesthetics during construction. Immediately after construction, the area would have a 'recently planted' somewhat manicured look. These impacts would decrease over a short period of time as the vegetation grows and water enters the channels. Revegetation and the removal of non-native vegetation along with the additive water features and willow swales would increase the aesthetics of the site after a few years of maturation.

6.15 Indian Trust Assets

Indian Trust Assets are legal interests in property held in trust by the United States for Indian tribes or individuals. Examples of trust assets include land, minerals, hunting and fishing rights, and water rights. The United States has an Indian Trust Responsibility to protect and maintain rights reserved by or granted to Indian tribes or individuals by treaties, statues, executive orders, and rights further interpreted by the courts. This trust responsibility requires that all Federal agencies take all actions reasonably necessary to protect such trust assets. There would be no effect on Indian Trust Assets by the Preferred Alternative, as all potential projects on Pueblo land are being coordinated with Pueblo input and approval.

6.16 Noxious Weeds

The Federal Noxious Weed Act of 1974 (Public law 93-269; 7 U.S.C. 2801) provides for the control and eradication of noxious weeds and their regulation in interstate and foreign commerce. Executive Order 13112 directs Federal agencies to prevent the introduction of invasive (exotic) species and to control and minimize the economic, ecological, and human health impacts that invasive species cause.

In addition, the State of New Mexico, under administration of the U.S. Department of Agriculture, designates and lists certain weed species as being noxious (Nellessen 2000). "Noxious" in this context means plants not native to New Mexico that may have a negative impact on the economy or environment and are targeted for management or control. Class C- listed weeds are common, widespread species that are fairly well established within the state. Management and suppression of Class C weeds is at the discretion of the lead agency. Class B weeds are considered common within certain regions of the state but are not widespread. Control objectives for Class B weeds are to prevent new infestations, and in areas where they are already abundant, to contain the infestation and prevent their further spread. Class A weeds have limited distributions within the state. Preventing new infestations and eliminating existing infestations is the priority for Class A weeds. In order to prevent this, all equipment would be cleaned with a high-pressure water jet before leaving an area and entering a new area. Portions of the Albuquerque Bosque Noxious Weed Management Plan (Parametrix 2007) would be incorporated into the Operations and Maintenance of the project.

These guidelines apply to both the removal of salt cedar, which is considered a Class C weed as well as the potential for Class A, B, or C weeds that might establish after thinning of non-native species occurs. It is anticipated that efforts to treat resprouts of non-natives and replanting of native species should delay new infestations of weedy species. This would, however, be monitored. Re-growth of all vegetation would be monitored throughout the duration of the project for infestation by noxious weeds and non-native species such as salt cedar and Russian olive. Therefore, it has been determined by the Corps that the Preferred Alternative is in compliance with the Federal Noxious Weed Act.

6.17 Herbicide Application and the Environmental Fate of Chemicals

Herbicide application would be used during implementation of the Preferred Alternative after treatment of non-native vegetation where root ripping is not an option as part of the clearing and removal process and subsequent OMRRR and adaptive management processes. Herbicide application would be used after manual and/or mechanical treatment of non-native vegetation. The preferred herbicides to use are Garlon®3A (for treatment of resprouts) and Garlon® 4 (for initial treatment). These are both selective herbicides which means that they can kill certain groups of plants and have little or no effect on other plants. These herbicides should not be used near surface water or saturated soils.

Garlon® is the commercial version of triclopyr and generally contains one or more inert ingredients. The contents of two triclopyr formulations are: Garlon® 3A: triclopyr (44.4%), and inert ingredients (55.6%) including water, emulsifiers, surfactants, and ethanol (1%); and Garlon ®4: triclopyr (61.6%), and inert ingredients (38.4%) including kerosene. Triclopyr acts by disturbing plant growth. It is absorbed by green bark, leaves and roots and moves throughout the plant. Triclopyr accumulates in the meristem (growth region) of the plant. Surfactants used would include non-ionic surfactants that have been approved for use in aquatic habitats (such as Induce).

Basal bark and cut surface treatments can be done at any time of year. Triclopyr should be applied only when there is little or no hazard of spray drift. It should be applied immediately to the stump of the cut tree (within two hours). Triclopyr is active in the soil, and is absorbed by plant roots. Microorganisms degrade triclopyr rapidly; the average half-life in soil is 46 days. Triclopyr degrades more rapidly under warm, moist conditions. The potential for leaching depends on the soil type, acidity and rainfall conditions. This herbicide is selective to woody plants and has little to no effect on grasses (Parker et al., 2005). It has been certified and labeled to be used near water by the Environmental Protection Agency (EPA, 1998). After use, the public must remain away form the area for 48 hours. Signage would be placed at areas after they have been treated.

Triclopyr is slightly toxic to practically non-toxic to soil microorganisms. Practically nontoxic is defined as a probable lethal oral dose for humans at less than 15 g/kg (Klaassen et al., 1986). Triclopyr is toxic to many plants if applied directly. Even very small amounts of spray may injure some plants. That is why it is to be applied directly to the stump of the tree being treated. The ester form of triclopyr, found in Garlon® 4, is more toxic, but under normal conditions, it rapidly breaks down in water to a less toxic form. Triclopyr is slightly toxic to practically non-toxic to invertebrates. Slightly toxic is defined as a probable lethal oral dose for humans at 5-15 g/kg (Klaassen et al., 1986). Triclopyr and its formulations have not been tested for chronic effects in aquatic animals. Triclopyr is slightly toxic to mammals. In mammals, most triclopyr is excreted, unchanged, in the urine. Triclopyr and its formulations have very low toxicity to birds. Triclopyr is non-toxic to bees. Triclopyr and its formulations have not been tested for chronic effects in terrestrial animals. The exposure levels a person could receive from these sources, as a result of routine operations, are below levels shown to cause harmful effects in laboratory studies. Inert ingredients found in triclopyr products may include water, petroleum solvents, kerosene, surfactants, emulsifiers, and methanol. Methanol, kerosene and petroleum solvents may be a toxic hazard if the pesticide is swallowed. Surfactants and emulsifiers are generally low in toxicity. The formulated products are generally less toxic than triclopyr. Garlon® 3A is a skin irritant and a severe eye irritant.

The U.S. Forest Service has evaluated health effects data in the development of both pesticide background statement documents and environmental impact statements for pesticide use on forest lands. These health effects evaluations have taken into consideration the potential for both worker and public exposure from Forest Service operations. This information has been used in assessing health risks and consequently in formulating protective measures to reduce risk to workers and to the public.

It has been found by other agencies in the area currently using these herbicides (MRGCD, OSD and the Bosque del Apache National Wildlife Refuge) that both Garlon® 4 (mixed 25-75% with vegetable oil) or Garlon® 3A (mixed 50-50% with water) have been successful.

Garlon® 4 would be used for initial treatment and has been shown to be more successful in cut-stump treatments (Doug Parker, personal communication). Garlon® 4 would be used for treatment of resprouts once they have grown at least 3 feet in height. Garlon® 3A has been shown to be more effective on smaller stems and resprouts (Doug Parker, personal communication).

Based on this information and the information described above, either herbicide may be used depending on site-specific conditions. Many of the areas are in high public use areas, and Arsenal® may be the preferred agent in those locations. In more remote areas and when adjacency to water is an issue, Garlon® may be used. This would be determined in the field based on the specific site locations. All required permitting and licensure would be obtained by the contractor. Prior to application, all chemicals would be specifically approved per the manufacturer's instructions. Follow-up inspections and monitoring after the herbicide application would be performed at all locations.

Therefore, it has been determined by the Corps that the Preferred Alternative is within compliance with all regulations pertaining to use of chemical herbicides. Although there may be short-term impacts on the bosque, these are more than outweighed by the long-term eradication of invasive plants.

6.18 Floodplains and Wetlands

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is at or near the surface or the land is covered by shallow water (Cowardin et al. 1979). Saturation with water determines the nature of soil development and, in turn, types of plant and animals inhabiting these areas. Wetlands occurring within the riparian zone may be dominated by the same plant species common in bosque; however, wetlands exhibit wetter soils and support many additional plant and animal species.

Historically, the Rio Grande channel wandered widely throughout the floodplain, and abandoned channels often contained sufficient groundwater discharge to support marshes (cienegas), sloughs (esteros), and oxbow lakes (charcos) (Scurlock 1998, Ackerly 1997). Currently, the extent of wetland plant communities within the project area reach has been significantly reduced. The groundwater elevation throughout the valley was significantly lowered by the construction of drains in the 1930s. Wetland areas throughout the floodplain have been directly displaced by agricultural and urban development. Irrigation and flood control operations have reduced the magnitude of discharges within the floodway, especially during the spring runoff period, and limit the extent of overbank flooding.

Jurisdictional wetlands (relative to Section 404 of the Clean water Act) do occur in the Study Area but not within the proposed project area. Most wetlands within the floodway have developed in areas with a high groundwater table. Those in shallow basins or relatively far from the river are likely seasonally or temporarily flooded; that is, inundated during the majority, or just a portion, of the growing season. Within the Rio Grande floodway, most islands, point bars and side channels are periodically inundated by river flows and support marsh, meadow or shrub wetland communities.

Abandoned channels or depressions deep enough to intersect the regional groundwater table often support permanent or semi-permanent flooded ponds and marshes. The San Antonio Oxbow is an example of this type within the Study Area, and is one of the largest wetland complexes in the Middle Rio Grande valley. This wetland's water regime is influenced by shallow groundwater, and surface water from the Rio Grande, San Antonio Arroyo, and the riverside drain.

These wetland communities would be avoided during implementation of the Proposed Action. Where possible, wet meadow areas would be created during the revegetation phase. This action would increase the wetland acreage in the Study Area.

Executive Order 11990 (Protection of Wetlands) requires the avoidance, to the extent possible, of long- and short-term adverse impacts associated with the destruction, modification, or other disturbances of wetland habitats. Wetlands within the project area would be left undisturbed and protected; therefore, the Proposed Action would not affect wetland communities in the Study Area.

Executive Order 11988 (Floodplain Management) provides Federal guidance for activities within the floodplains of inland and coastal waters. Preservation of the natural values of floodplains is critically important to the nation and the State of New Mexico. Federal agencies are required to "ensure that its planning programs and budget requests reflect consideration of flood hazards and floodplain management." Removal of the non-native vegetation and construction of water-related features may allow additional inundation within the current boundaries of the floodplain. But, since bank-line jetty jacks are to remain in place, any major changes to the floodplain would most likely not occur.

Therefore, the Preferred Alternative is unlikely to negatively affect the floodplain and is in compliance with Executive Order 11990. Instead, positive impacts are anticipated, although they are unlikely to be significant.

6.19 Cumulative Effects

Cumulative effects are "*the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions* " (40 CFR §1508.7). The geographic extents for which cumulative effects are considered vary for each of the resources analyzed. Similarly, actions taken in the past, present, and reasonably foreseeable future within the Study Area, when combined with the actions in the Preferred Alternative, could contribute to cumulative effects and may vary with the resource being considered. Environmental impacts associated with the bosque in Albuquerque have been evaluated relative to the Preferred Alternative.

6.19.1 Other projects in the region

Construction of Cochiti Dam in the 1960s has resulted in the ongoing degradation of the Rio Grande channel and its riparian zone both upstream and downstream of the structure. It is anticipated that the adverse environmental impacts attributed to its placement and traditional operation would continue in the future as long as it is operated for existing purposes and in the present manner. Its impacts to the immediate and surrounding landscape and local terrestrial ecosystem have stabilized since its construction.

Currently, the Corps, BOR, and the NMISC are signatories of the Memorandum of Agreement to conduct the Upper Rio Grande Water Operations Review (URGWOR) and prepare a Programmatic Water Operations

Environmental Impact Statement. They are also all partners in the MRGESCP and constructing projects as described above. The URGWOR study is being prepared by the parties in accordance with NEPA and would present alternatives for analyzing water operations at Federally-operated facilities in the Upper Rio Grande Basin and would evaluate the environmental, economic, and social effects of these alternatives. It is not anticipated that the Preferred Alternative would add cumulatively to the environmental effects of any of the water operations alternatives that may be considered and/or adopted by the water operations review.

The MRGESCP is a multi-agency organization that has funded a number of habitat restoration projects in the Study Area. The Corps, BOR and NMISC have all constructed projects within the Study Area under the MRGESCP. These projects have been planned and constructed in coordination with each other and the development of the Route 66 Project. They have been planned so that they complement one another and do not overlap. The culmination of these projects will provide additional habitat for all species, and especially the Rio Grande silvery minnow and Southwestern Willow Flycatcher. Since they have been constructed during different times and not in overlapping geographic areas, it is anticipated there would be no cumulative negative impact considered in these projects, but potentially a cumulative positive benefit.

The Corps is involved in another 1135 Ecosystem Restoration projects within the RGVSP between I-40 and Bridge Boulevard. Construction of the Bio-Park Project south of Central Avenue was completed in the fall of 2005. The Preferred Alternative would not conflict with these plans and took them into consideration during plan formulation. These projects would benefit one another.

Under the Bosque Wildfire project, activities of selective thinning of areas with high fuel loads and/or non-native plant species populations; removal of jetty jacks and removal of debris; improvement of emergency access in the form of drain crossings, levee road improvement, and construction of turnarounds; and revegetation of burned areas began in 2004 in and around the Albuquerque area, including the Study Area. Jetty jacks have been removed in Solution Areas A, C, E, and B. Debris has been removed from Solution Areas G, E, and C. These areas are also being retreated for resprouts of non-native vegetation. Revegetation in some of these areas has also begun in coordination with the Preferred Alternative. Again, these actions were planned and coordinated to provide an overall beneficial effect to the system.

6.19.2 Geomorphology & Hydrology

As described above, the Preferred Alternative would likely have positive effects on the geomorphology and hydrology as they relate to the environment of the Study Area. The effects of past projects have been documented, and this project attempts to rectify some of the impacts caused by those earlier projects. In addition, there are other projects planned for this area which would work in harmony with he Preferred Alternative to enhance ecosystem health and function in the Albuquerque reach. Therefore, the cumulative effects on the geomorphology and hydrology of the Study Area would not negatively impact the Study Area.

6.19.3 Water Quality

For the Preferred Alternative to have cumulative effects on water quality in the Rio Grande, a threshold in concentration of some pollutant, due to the effects of the Preferred Alternative, would have to be exceeded. In this scenario, the additive effect of a pollutant due to actions taken in the Preferred Alternative combined with existing water quality conditions would have to exceed a toxicity level or water quality standard. As described in Section 2.4, the additive effect of sediment impacts in the Rio Grande from the Preferred Alternative is likely to be immeasurable. The Preferred Alternative would not have any additive, long-term impacts to existing chronic effects the potentially lead to adverse water quality impacts on the Rio Grande. There could be some minor, localized, long-term beneficial effects to shallow groundwater and surface water in the Rio Grande from removal of pollutants by project features such as wetlands and over-bank channels. In summary, cumulative adverse effects on water quality as a result of the Preferred Alternative would not occur.

6.19.4 Air Quality and Noise

There would be minor cumulative effects to air quality and noise levels during the project construction periods. However, the additive effects on noise and air quality would not extend beyond the period of equipment operation. During the period of construction, effects on air quality or noise wouldn't be likely to exceed any critical environmental thresholds due to the Preferred Alternative.

6.19.5 Ecological Resources

The Preferred Alternative would have beneficial effects on restoration of native riparian vegetation and wet habitat in the Study Area. Therefore, there would be no adverse cumulative effects from implementing the Preferred Alternative. Non-native vegetation removal in the Study Area would consist largely of maintaining past vegetation-clearing efforts and would not cause substantial alteration of habitat structure. Planting of native species would set forest and woodland stands on a trajectory of improving vegetation structure and species composition. These project features would not cause adverse cumulative impacts to wildlife habitat. Additionally, habitat diversity would be improved by the Preferred Alternative.

Because the Study Area is within a State park and is located in the middle of a major metropolitan area, recreational use and demand is high and widespread throughout the bosque. Increased recreation use in the Study Area would be likely to occur with implementation of the Preferred Alternative, albeit in a more limited area. Much of the Study Area currently is subject to disturbance from recreational uses. Implementation of the Preferred Alternative could cumulatively add to ongoing adverse impacts to wildlife habitat from recreation uses. However, these additive impacts are not likely to exceed a threshold in habitat suitability throughout the Study Area for any species of wildlife.

While revegetation eventually avoids a significant adverse effect of the Preferred Alternative, there would remain a short-term adverse effect on wildlife populations until planted shrub communities mature. It is estimated that a minimum of 10 years would be required for planted shrubs to be achieve stature and densities resembling existing conditions.

In summary, it is proposed that this project would have a positive impact on the environment resulting from the potential cumulative effects of other Federal and non-Federal agencies.

6.19.6 Recreation and Interpretive Resources

A number of new recreational and interpretive features have been proposed for the Study Area, which would increase access and opportunities throughout the Study Area. They would also provide a more permanent and environmentally sound structure for such activities through formalizing and stabilizing trails, eliminating redundant trails, and providing new features, such as wildlife blinds, viewing areas, interpretive signage and benches. Although recreational access in the Study Area would be temporarily limited during the construction process, the Preferred Alternative would only have a positive additive, long-term impact on the recreational and interpretive value of the Rio Grande bosque. In summary, cumulative adverse effects on recreation and interpretive resources as a result of the Preferred Alternative would become strongly positive once the project is completed.

6.20 Aesthetics

Although aesthetics would be temporarily impacted during the construction process (increased amount of bare earth areas and staging areas), the Preferred Alternative would have a net positive additive and long-term impact on the aesthetic value of the Rio Grande bosque in the Study Area. In summary, cumulative effects are likely to improve overall aesthetics.

6.21 Irreversible and Irretrievable Commitment of Resources

An irreversible and irretrievable impact is the commitment of resources that are lost forever. There are no foreseeable irreversible and irreversible commitments of resources associated with this project. Procedures to ensure the security and integrity of any resource would be diligently maintained at all times.

6.22 Conclusion

The summary of effects below includes some short-term adverse effects that will result in long-term benefits. A summary of BMPs to be implemented during the project area also provided.

Table 6.2 Summary of Effects

Existing Environment	*Foreseeable Effects*
Physiography, Geology, Soils	Short-term temporary adverse effect on soils
Hydrology and Hydraulics	No effect
Water Quality	No effect
Air Quality and Noise	Negligible, short-term adverse effects
Plant Communities	Short-term negative effects with long-term positive effects
Fish and Wildlife	Short-term negative effects with long-term positive effects
Endangered and Protected Species	May affect but not likely to adversely effect: Southwester Willow Flycatcher, Bald Eagle, Yellow-Billed Cuckoo, Rio Grande silvery minnow critical habitat, Yuma myotis, Occult little brown bat; No effect to: Neotropic Cormorant, Common Black-Hawk, Whooping Crane, Black Tern, Bell’s Vireo, Flathead chub, Pecos River muskrat, New Mexico meadow jumping mouse
Rio Grande silvery minnow	Direct short-term adverse effect during construction, Long-term beneficial effect, Not likely to jeopardize continued existence
Cultural Resources	No adverse effect to Historic Properties
Socioeconomic Considerations	No adverse effect
Environmental Justice	No adverse effect
Land Use	No adverse effect
Recreational Resources	Short-term negative effects with long-term positive effects
Aesthetics	Short-term negative effects with long-term positive effects
Indian Trust Assets	No adverse effect
Floodplains and Wetlands	No adverse effect

Summary of BMPs to be implemented during construction:

1) Silt fence (without lead weights) would be installed adjacent to the riverbank to prevent erosion to the river.

2) Fueling of vehicles would not take place in the bosque.

3) Cleaning of all equipment is required prior to entering the site.

4) A Corps' biologist would monitor the project during construction at the bank of the river in order to detect any potential silvery minnow in the area. Findings of injured or dead silvery minnows would be reported to the Service. Water quality measurements would be taken before, during and after construction activity.

5) In coordination with the Service, a protocol to monitor presence/absence of silvery minnows in the channels following high flows, and to determine whether channel maintenance is warranted, would be developed.

6) Construction activities would take place in designated areas only, avoiding any unnecessary damage to the riparian area.

7) Work inside of the bosque would not occur between May 1 and August 30.

8) Work would be scheduled, to the extent possible, embayment construction during dry or frozen soil conditions.

9) Cofferdams, dikes, straw bales or other suitable erosion control measures would be utilized during construction as necessary.

10) Storage and dispensing of fuels, lubricants, hydraulic fluids, and other petrochemicals would take place only outside the 100-year floodplain. Construction equipment would be inspected daily for petrochemical leaks. Any spills would be contained and removed. These materials would be disposed of at an approved upland site. Construction equipment would be parked outside the 100-year floodplain during periods of inactivity.

11) Equipment operators would be required to carry an oil spill kit or spill blanket at all times and are required to be knowledgeable in the use of spill containment equipment. A spill contingency plan would be developed prior to initiation of construction. The proper Federal and state authorities would be notified immediately in the event of a spill.

12) Existing roads and right-of-ways and staging areas should be used to the greatest extent practicable to transport equipment and construction materials to the project site,.

13) Any backfill required would be uncontaminated earth or alluvium suitable for re-vegetation with native plant species.

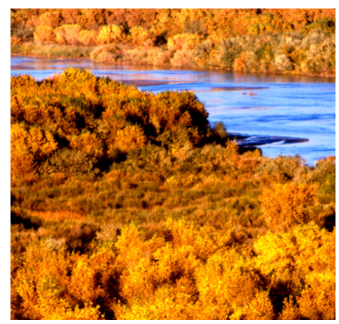
14) Compacted soils would be scarified or replaced with topsoil and revegetate all disturbed sites with suitable mixture of native grasses, forbs, and woody shrubs.

15) Existing mature cottonwood trees would be protected from damage during clearing of non-native species or other construction activities using fencing, or other appropriate materials.

16) Where possible, use local genetic stock in the native plant species establishment throughout the riparian area would be utilized.

Based upon the analysis of potential effects in Section 6, the BMPs to be implemented during construction, and the goal of the project to restore the bosque ecosystem, it is anticipated the project will have an overall positive benefit to the bosque and Middle Rio Grande in the Study Area.

Section 7 Recommendations



As District Engineer, Albuquerque District, U.S. Army Corps of Engineers, I have weighed the ecosystem benefits to be gained from implementing the recommended habitat restoration plan in the bosque against the cost, and have considered the alternatives, impacts, and scope of the proposed project. In my judgment, the proposed project is a justified expenditure of Federal funds. The proposed project is fully consistent with the authorized purposes of Jemez and Cochiti Dams and would not have any effect on their operation or maintenance. I recommend that the Secretary of the Army approve the Ecosystem Revitalization @ Route 66 Project in the City of Albuquerque.

Total estimated cost of the project is $6,600,000. The project sponsor, the Middle Rio Grande Conservancy District (MRGCD), non-Federal share is $1,816,000 of the total project cost. All future operation and maintenance responsibilities for the structures and features implemented in the recommended plan would be borne by the MRGCD.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of restoration projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted as proposals for implementation funding. However, prior to transmittal, the sponsor, the States, interested Federal agencies, and other parties would be advised of any modifications and would be afforded an opportunity to comment further.

23 Jul 08
Date

For Kimberly Colloton
Lieutenant Colonel, U.S. Army
District Engineer

Section 8 Preparation, Coordination and Consultation

8.1 Preparation

This Detailed Project Report/Environmental Assessment was prepared by the U.S. Army Corps of Engineers, Albuquerque District. The Project Delivery Team and principal preparers included:

Albuquerque Project Delivery Team:

Fritz Blake, Project Manager, Civil Project Management Branch
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Maura Lewiecki, ASLA, Plan Formulation & Graphic Design, Sites Southwest
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John Barney (contributed to early draft)

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Tony Apodaca, Senior Planner, Plan Formulation Section
Armando Najera, Acting Chief, Hydrology & Hydraulics Section
William DeRagon, Senior Biologist, Environmental Resources Section
Gregory Everhart, Archaeologist, Environmental Resources Section
Gary Rutherford, Project Manager, Civil Project Management Division
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8.2 Coordination and Consultation

Albuquerque Metropolitan Arroyo Flood Control Authority
Bernalillo County
Bureau of Land Management
City of Albuquerque
Middle Rio Grande Conservancy District
National Hispanic Cultural Center
Natural Resource Conservation Service
New Mexico Department of Energy, Minerals, and Natural Resources
New Mexico Forestry Division

New Mexico Department of Game and Fish
New Mexico Environment Department
New Mexico Interstate Stream Commission
New Mexico Natural Heritage Program
New Mexico Office of the State Engineer
New Mexico State Historic Preservation Office
Pueblo of Isleta
Pueblo of Sandia
U.S. Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Hopi Tribe
Navajo Nation
Pueblo of Laguna
White Mountain Apache Tribe

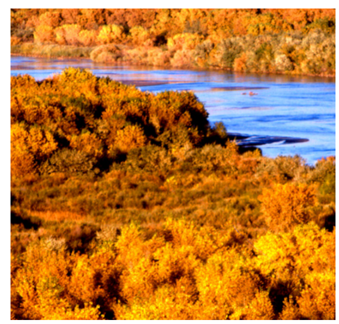
This Preferred Alternative has been coordinated with the U.S. Fish and Wildlife Service in compliance with the Fish and Wildlife Coordination Act of 1958 and the Endangered Species Act of 1973 (see Appendix B).

Coordination under Section 106 of the National Historic Preservation Act has been conducted with the New Mexico State Historic Preservation Officer (Appendix C).

8.3 Public Review and Comment

Scoping letters were sent to various public agencies and interested public (see Appendix A) and meetings were held in regard to the project during the planning process. Input was received and is in Appendix A. The Draft DPR/EA was available for public review and input from March 19 through April 18, 2008. A public meeting was held on April 2, 2008. Comments were received and addressed (Appendix G)..

Section 9 References



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